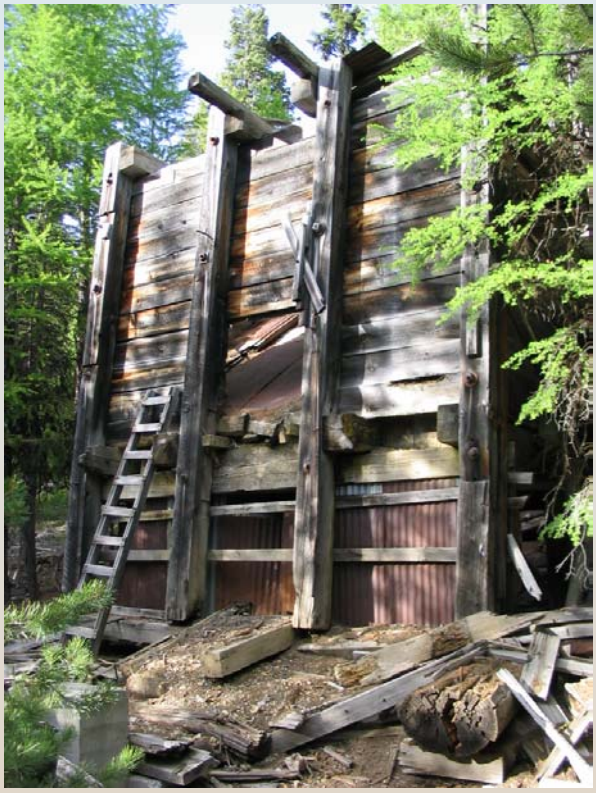
PYX MINE

Wallowa-Whitman National Forest
Grant County, Oregon



SITE INSPECTION

February 6, 2009

Prepared For:
USDA Forest Service
Gifford Pinchot National Forest
10600 NE 51st Circle
Vancouver, WA 98682

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SITE INSPECTION REPORT

Pyx Mine
Wallowa-Whitman National Forest, Oregon — February 2009

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ACRONYMS AND ABBREVIATIONS

%R	Percent recovery
bcy	Bank cubic yard
$CaCO_3$	Calcium carbonate
gpm	Gallon per minute
mg/kg	Milligram per kilogram
mg/L	Milligram per liter
sf	Square feet
ABA	Acid Base Accounting
AGP	Acid Generating Potential
amsl	Above mean sea level
ANP	Acid Neutralizing Potential
APA	Abbreviated Preliminary Assessment
bgs	Below ground surface
BLM	United States Bureau of Land Management
CERCLA	Comprehensive Environmental Response, Compensation & Liability Act
COI	Contaminant of interest
COPC	Contaminant of potential concern
CPEC	Contaminant of potential ecological concern
CTE	Central tendency exposure
Eco-SSL	Ecological Soil Screening Level
ECR	Excess cancer risk
EE/CA	Engineering Evaluation/Cost Analysis
EF	Exposure factor
EPA	United States Environmental Protection Agency
ERA	Ecological risk assessment
FR	Forest Road
FWS	U.S. Fish and Wildlife Service
GPS	Global positioning system
HHRA	Human health risk assessment
HI	Hazard index
HUC	Hydrologic unit code
LCS/LCSD	Laboratory control sample/ laboratory control sample duplicate
MCL	Maximum contaminant level
MDC	Maximum detected concentration
MS/MSD	Matrix spike/matrix spike duplicate
MSE	Millennium Science and Engineering, Inc.
NFS	National Forest System
NNP	Net neutralization potential

ACRONYMS AND ABBREVIATIONS (Continued)

ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
ODGMI	Oregon Department of Geology and Mineral Industries
ONHP	Oregon Natural Heritage Program
PEL	Probable effects level
PRG	Preliminary remediation goal
QA	Quality assurance
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RL	Reporting limit
RMC	Risk Management Criteria
RME	Reasonable maximum exposure
RPD	Relative percent difference
SI	Site inspection
SLV	Screening level value
SOC	Species of concern
SPLP	Synthetic Precipitation Leaching Procedure
SVL	SVL Analytical Laboratory
T&E	Threatened and endangered
TEL	Threshold effects level
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total dissolved solids
TOC	Total organic carbon
TOM	Total organic matter
UCL_{90}	90 percent upper confidence limit
USGS	United States Geological Survey
WAD	Weak acid dissociable
WRCC	Western Regional Climate Center
XRF	X-Ray Fluorescence

EXECUTIVE SUMMARY

- The Pyx Mine is an inactive gold mine and millsite, located about 6 miles southwest of Granite, Oregon in the Wallowa-Whitman National Forest.
- Under contract to the USDA Forest Service (Forest Service), Millennium Science and Engineering, Inc. (MSE) completed a Site Inspection (SI) of the Pyx Mine (Site) to:
  - Characterize site features and physical hazards;
  - Assess potential risks to human and ecological receptors at the Site from exposure to mine wastes;
  - Estimate mine waste quantities; and
  - Determine background soil concentrations.
- This report describes the SI field investigation activities and summarizes analytical results, mine waste volume estimates, a physical hazards assessment, and streamlined human health and ecological risk assessments.
- Site features at the Pyx Mine include:
  - One open adit
  - One waste rock pile
  - A tailings impoundment
  - Remnants of a wooden mill
- A total of 21 samples were collected from the background soils, mine waste (waste rock and tailings), sediment, and surface water. Only one sediment sample and one surface water sample were collected.
  - Analytical results of the samples indicate elevated concentrations of several metals, particularly arsenic, in the mine waste.
  - Metals concentrations in the sediment sample were significantly lower and only a few metals were detected in the surface water samples.
  - Potential acid generation in the mine waste is very low, and there is no obvious evidence of contaminant migration from the Site.
- Streamlined human health and ecological risk assessments for the following pathways were completed to assess potential risks to human and ecological receptors at the Site.
  - **Groundwater Pathway:** The groundwater pathway is incomplete because there is no drinking water source at the Site and no wells within a 1-mile radius.
  - **Surface Water Pathway:** The surface water pathway is complete for human and ecological receptors but insignificant because of the low metals concentrations.
  - **Soil Pathway:** The soil pathway is complete and significant for both human and ecological receptors because of elevated metals concentrations in the mine waste.
  - **Air Pathway:** The air pathway is complete for human receptors but insignificant because of extremely low risk levels.
- Results of the streamlined human health risk assessment (HHRA) indicate risk from exposure to metals in mine wastes at the Site.
  - Two human health contaminants of potential concern (COPC) were identified: arsenic and mercury.
  - The most significant exposure pathway is ingestion of and dermal contact with the mine waste.
  - Inhalation of particulates from the mine waste, and incidental ingestion of and dermal contact with surface water and sediment contribute minimal risk and are insignificant pathways.
  - Non-carcinogenic hazards were below the acceptable level for all receptors under both the central tendency exposure (CTE) scenario and reasonable maximum exposure (RME) scenario.

- There is moderate carcinogenic risk to all receptors under the RME scenario from exposure to arsenic in the mine waste. Under the CTE scenario, carcinogenic risks were below the acceptable level for all receptors.
- A risk-based hot spot concentration and cleanup level for arsenic in mine waste were back calculated using risk equations from the streamlined HHRA.
  - No areas exceeded the hot spot concentration of 460 milligrams per kilogram (mg/kg).
  - Two areas exceeded the arsenic cleanup level of 46 mg/kg:
    - Waste rock pile WR1 = 62.9 mg/kg
    - Tailings impoundment = 364 mg/kg
    - Total estimated volume of mine waste above the cleanup level = 3,740 bank cubic yards (bcy)
- Lead risks were not quantified because of the lack of established toxicological data and the limitations of current lead exposure models. However, the maximum detected lead concentration (1,210 mg/kg) at the Site is well below Oregon's Industrial Maximum Allowable Soil Concentration Cleanup Level (2,000 mg/kg).

- Results of the streamlined ecological risk assessment (ERA) indicate potential risk to ecological receptors at the Site from exposure to metals in mine waste and sediment; however, the risks are at the individual level rather than the population level. While individual receptors may be exposed to metals in mine wastes at the Site, their populations are unlikely to be significantly impacted because it is improbable that entire populations of receptors reside strictly within the bounds of the Site.
  - Several contaminants of potential ecological concern (CPEC) were identified, most notably iron, lead and mercury.
  - The highest risk ratios are from exposure to the mine waste; there is also limited risk to individual aquatic receptors from exposure to zinc in the sediment.
  - There appears to be very limited ecological risk from exposure to surface water at the Site.
- There is no documented evidence of sensitive or threatened and endangered (T&E) species at the Site and none were observed during the field investigation by MSE in June 2008, or during the site reconnaissance in October 2007.
  - However, the Wallowa-Whitman National Forest is listed as providing habitat for several T&E species, including the bald eagle and Canada lynx.
  - Although these animals may occasionally traverse the Site, it is unlikely that their habitat would be limited to within the site bounds.
- Physical hazards at the Site consist of a partially collapsed adit, a wooden mill frame, and potentially an open shaft that has not been located.
- Based on the results of this SI and the streamlined HHRA, MSE recommends performing a streamlined Engineering Evaluation/Cost Analysis (EE/CA) to address physical hazards at the Site and potential human health risks from exposure to arsenic in the mine waste.

SITE INSPECTION DATA SUMMARY SHEET

Project Name: Pyx Mine Site Inspection
Project Location: Between forks of McWillis Gulch in Section 2, Township 10 South, Range 35 East in Grant County, OR
Latitude: 44° 43' 41" N Longitude: 118° 26' 57" W Elevation: 5,770 feet amsl
Nearest Surface Water Body: Pond and unnamed tributary to Olive Creek ~ 1,000 feet Area of Disturbance: Approximately 2 acres

SUMMARY OF SITE CHARACTERIZATION ANALYTICAL RESULTS

Medium	Volume/Rate of Discharge	Contaminant of Potential Concern[a]	Maximum Detected Concentration	Lowest Screening Criteria	Background Concentrations[b]
Mine Waste	4,230 bcy	Silver	5.45 mg/kg	2.0 mg/kg – Eco	0.25 mg/kg
		Arsenic	364 mg/kg	1.6 mg/kg – HH	5.7 mg/kg
		Cadmium	9.65 mg/kg	0.36 mg/kg – Eco	1.24 mg/kg
		Copper	110 mg/kg	50 mg/kg – Eco	14.4 mg/kg
		Iron	28,500 mg/kg	10 mg/kg – Eco	13,200 mg/kg
		Mercury[c]	375 mg/kg	0.1 mg/kg – Eco	0.045 mg/kg
		Lead	1,210 mg/kg	11 mg/kg – Eco	7.09 mg/kg
		Antimony	1.6 mg/kg	0.27 mg/kg – Eco	1.0 mg/kg
		Selenium	5.6 mg/kg	1.0 mg/kg – Eco	2.0 mg/kg
		Zinc	135 mg/kg	50 mg/kg – Eco	85.1 mg/kg
Sediment	NM	Copper	34.2 mg/kg	10 mg/kg – Eco	Not measured
		Zinc	33.7 mg/kg	3.0 mg/kg – Eco	Not measured
		Arsenic	5.4 mg/kg	1.6 mg/kg – HH	Not measured

Notes:
[a]Only significant contaminants with concentrations above background and greater than 1.5x screening criteria are reported in this table.
[b]Background concentrations for mine waste based on 90 percent upper confidence limits (UCL_{90}) for background soil samples. If the UCL_{90} was above the maximum detected concentration (MDC), the MDC was used. No background samples were collected for sediment or surface water.
[c]The maximum detected mercury concentration of 375 mg/kg is more than two orders of magnitude higher than reported in any other sample and may be an anomaly.
amsl = Above mean sea level
bcy = Bank cubic yards
mg/kg = Milligram per kilogram
mg/L = Milligram per liter
Eco = Ecological; HH = Human health, NM = Not measured

1.0 INTRODUCTION

- Millennium Science and Engineering, Inc. (MSE) was contracted by the USDA Forest Service (Forest Service) to perform a Site Inspection (SI) of the Pyx Mine in the Wallowa-Whitman National Forest in Grant County, Oregon.
- This report describes the SI field investigation activities and summarizes analytical results, mine waste volume estimates, a physical hazards assessment, and streamlined human health and ecological risk assessments.
- The SI was performed in general accordance with the following U.S. Environmental Protection Agency (EPA) guidelines and state and federal regulations:
  - CERCLA;
  - SARA;
  - NCP 40CFR 300.415(b)(4)(i);
  - EPA's *"Guidance for Performing Site Inspections Under CERCLA"* (1992);
  - EPA's *"Risk Assessment Guidance for Superfund (RAGS), Volume 1: Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals)"* (1991);
  - EPA's *"Risk Assessment Guidance for Superfund Volume II – Environmental Evaluation Manual"* (2001);
  - EPA's *"Risk Assessment Guidance for Superfund, Part E, Supplemental Guidance for Dermal Risk Assessment"* (2004a);
  - EPA's *"Region 10 Supplemental Ecological Risk Assessment Guidance for Superfund"* (1997a);
  - EPA's *"Exposure Factors Handbook"* (1997b);
  - Oregon Department of Environmental Quality's (ODEQ) *"Guidance for Conduct of Deterministic Human Health Risk Assessment"* (2000a);
  - ODEQ's *"Guidance for Ecological Risk Assessment"* (2001); and
  - Oregon Administrative Rules (OAR) 340-122-084, Sections 010 through 115 (ODEQ 2000b).

1.1 Purpose and Objectives

- The SI is a component of the Superfund Accelerated Cleanup Model, devised by EPA to meet the requirements of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, EPA 1992).
- The Pyx Mine SI is intended to provide sufficient and appropriate information for: (1) assessing potential risks to human health and the environment, and (2) developing and evaluating potential removal action alternatives.
- Primary objectives of the Pyx Mine SI were to:
  - Determine if a release has occurred;
  - Estimate the volume and extent of an existing or potential release;
  - Evaluate existing or potential impacts to terrestrial habitats;
  - Evaluate existing or potential risk to human and ecological receptors and, if necessary, establish appropriate risk-based, site-specific, clean up levels; and
  - Estimate 90 percent Upper Confidence Limits (UCL_{90}) for background concentrations.

1.2 Site Description

- The Pyx Mine is an inactive gold mine and millsite located about 6 aerial miles southwest of Granite, Oregon (Figure 1).

- The Site location is described as:
  - Southeast quarter of Section 1, Township 10 South, Range 35 East of the Willamette Meridian;
  - Latitude = 44° 43' 41"N;
  - Longitude = 118° 26' 57"W; and
  - Elevation = 5,770 feet above mean sea level (amsl).
- Access to the Site is from State Route 7 by traveling north on Greenhorn Road (County Route 503) along the North Fork Burnt River for 8.7 miles. Turn right on Forest Road (FR) 180 and proceed 0.1 miles. Continue east on FR 180 at fork in road for 0.5 miles. Turn left on FR 185 and go north for 0.3 miles. Turn left on FR 186 and continue for 0.5 miles north to the Site.
- The Site is located near the top of a small drainage.
  - There are no stream flows in the drainage above the Site but water seasonally discharges from the adit at a very low flow rate.
    - During the June 2008 field investigation by MSE, the flow from the adit was too low to measure and was estimated to be <1 gallon per minute (gpm).
    - The flow travels only a short distance (~100 feet) before infiltrating.
- Site features include:
  - A partially collapsed adit
  - One waste rock pile
  - A tailings impoundment
  - Remnants of a wooden mill structure
  - Miscellaneous wood and metal debris
- The total estimated volume of mine waste at the Site is 4,230 bank cubic yards (bcy):
  - The estimated volume of waste rock pile WR1 is 3,200 bcy.
  - The estimated volume of contaminated soil around the mill foundation is 430 bcy.
  - The estimated volume of tailings in the conveyance channel between the mill and the tailings impoundment is 60 bcy.
  - The estimated volume of tailings in the impoundment is 540 bcy.
- A more detailed description of the Site is provided in Section 2.1.

1.2.1 Climate

- Available climate data for the Site was obtained from the Western Regional Climate Center (WRCC) website (2008).
- The nearest climate station is located in Granite, Oregon (6 miles northeast of the Site) at an elevation of 4,940 feet amsl.
- Because the Site is significantly higher in elevation at 5,770 feet amsl, it likely receives significantly more precipitation and has lower maximum and minimum temperatures.
- Climate data from the Granite station is presented in Table 1 and summarized below:
  - Total average precipitation = 26.4 inches per year
  - Total average snowfall = 174 inches per year
  - Mean minimum temperature = 26.2° F
  - Mean maximum temperature = 52.6° F

1.2.2 Regional Geology

- The Site is located in the Blue Mountain physiographic province of northeastern Oregon.
  - The Blue Mountains are characterized by a complex assemblage of distinct exotic terranes that were accreted on the western coast of the North American craton during the Triassic and

Jurassic periods. Each of these terranes consists of a distinctive suite of volcanic, sedimentary and metamorphic rocks with later intrusive granitic bodies (Orr and others 1992).

- The Site is located within the Baker Terrane, which forms the core of the Greenhorn Mountains characterized by narrow valleys with glaciated peaks up to approximately 8,000 feet amsl.
- The Baker Terrane is composed of several formations beginning with the Permian Burnt River schist, which is overlain by the Triassic Elkhorn Ridge argillite.
  - During the Cretaceous period, these units were intruded by granitic batholiths of granodiorite and gabbro (Orr and others 1992; Oregon Department of Geology and Mineral Industries [ODGMI] 1976). The contact between the native rock and the intrusive bodies was the primary zone of mineralization that was the target of area hardrock mines.
  - During the Tertiary period, the area was subject to intense volcanism that covered much of the region with widespread lava and ash deposits (Orr and others 1992).
  - During the Pleistocene period, the mountainous regions were subject to alpine glaciation.

- Available information from regional mining reports indicates that the Pyx Mine targeted a mineralized vein of quartz and pyrite within a host rock of argillite (ODGMI 1941, 1959, 1968).

1.2.3 Hydrogeology

- Hydrogeologic information for the Site was based primarily on visual inspection of the Site and area well logs.
- The Site is located in a bedrock unit (Elkhorn Ridge granodiorite) that generally exhibits low permeability.
- Although no drinking water wells appear to be located near the Site, bedrock does provide a source of groundwater in the region.
- Review of well logs located in Section 22 and 21 (T10S, R35E) indicate a low yielding fractured bedrock aquifer with typical well production rates of 2 to 4 gpm.
  - According to the well logs, these wells were typically completed within granite or basalt with groundwater first encountered approximately 90 to 120 feet below ground surface (bgs).
- Bedrock typically exhibits low permeability, unless the unit has been fractured through folds, faulting, drilling, or mining practices.
- According to historical mining records at the Pyx Mine, a shaft 150 feet in depth is "full of water" (ODGMI 1941).
  - This indicates the hydrogeology in the vicinity of the Site is likely dominated by heterogeneous fracture flow within the bedrock aquifer and the shaft intercepted a water-bearing fracture.
  - The connection between the fractured bedrock aquifer and area surface water is unknown. However, groundwater within the fractured bedrock system likely discharges to McWillis Gulch and ultimately Olive Creek.
  - A small pond and spring are located in McWillis Gulch approximately 1,000 feet downslope from the Site, as indicated on the U.S. Geologic Survey (USGS) Greenhorn Quadrangle. This likely represents a point of groundwater discharge for the Site.

1.2.4 Hydrology

- The Site is located near the top of a small drainage that ranges in elevation from 5,600 to 5,800 feet amsl.

- The drainage is not confined and there is not an established stream channel above the Site. In the lower portion of the Site, two small, defined channels appear to have formed from storm water runoff and erosion.
  - The channels were dry during both the site reconnaissance in October 2007 and the field investigation in June 2008.
- During the field investigation in June 2008, water was observed discharging from the collapsed adit.
  - The flow travels about 140 feet before infiltrating in the top of the waste rock pile.
  - The flow was too low to be measured and was visually estimated to be < 1 gpm.
  - Water was not discharging from the adit during the site reconnaissance in October 2007.
- The nearest water body appears to be a small pond in McWillis Gulch approximately 1,000 feet downslope from the Site.
- The following is a USGS hydrologic unit code (HUC) description of the stream watershed relationships (USGS 2008):
  - Stream Order:
    →Olive Creek
      →Clear Creek
        →Granite Creek
          →North Fork John Day River
            →John Day River
              →Columbia River
  - Watershed Association:
    →Beaver Creek - Subwatershed
      →Granite Creek - Watershed
        →North Fork John Day - Subbasin
          →John Day - Basin
            →Middle Columbia - Subregion
              →Pacific Northwest – Region

1.2.5 Wetlands

- Wetlands information was retrieved from the U.S. Fish and Wildlife Service (FWS) National Wetlands Inventory through the wetland online mapper at http://wetlandsfws.er.usgs.gov, and the National Wetlands Inventory by the Department of Agriculture. There were no identified wetlands on or near the Site.
- During the field investigation, a seasonal wetted area was identified and is described in the Oregon Natural Heritage Program (ONHP) GAP vegetation analysis.
  - The area can be described as a wet meadow. These small montane herbaceous meadows are composed primarily of grass-like plants.
  - The soils are saturated for the majority of the spring season (May to June).
  - The Carex dominant meadows have areas of dense sedge turf. Common species found in this typical habitat include Carex species specifically beaked sedge, water sedge, wooly sedge, thickheaded sedge, and lenticular sedge (ONHP 2007).
  - There was not outflow from this seasonal wetted area.

1.2.6 Terrestrial Habitat

- The Site is located in the Wallowa-Whitman National Forest within the Blue Mountains Ecoregion.

- Terrestrial habitats in the vicinity are dominated by a Grand Fir/Elk Sedge Plant Association as defined in *"Alpine and Subalpine Vegetation of the Wallowa, Seven Devils and Blue Mountains"* (Johnson 2004).
  - This plant association is found along moderate convex slopes. They are generally southwest facing at mid to lower slope positions at elevations ranging from 5,400 to 6,200 feet amsl.
- The typical vegetation composition for this type of habitat is commonly comprised of late seral stands, dominated by Grand Fir.
  - Douglas Fir is also associated with the canopy overstory. Western larch, lodgepole pine and Englemann spruce were also observed and indicate forest regeneration after wildfires.
  - The understory consists mainly of elk sedge. Ross' sedge and Columbia brome are found in areas of lower coverage levels.
  - Other common plants include bigleaf sandwart, white hawkweed, and sidebells pyrola.
- A list of plants and animals known to inhabit North Fork John Day Watershed are identified by the Oregon Department of Fish and Wildlife (ODFW) and included in Appendix A (ODFW 2008).

1.2.7 Threatened and Endangered Species

- Information regarding threatened and endangered (T&E) species and species of concern (SOC) for wildlife and plant species occurring in Blue Mountains Ecoregion was obtained from the ODFW (ODFW 2008) and the ONHP (ONHP 2007) and are listed in Appendix A.
- Animal and plant species listed as T&E within the Wallowa-Whitman National Forest and specifically Grant County are also listed in Appendix A.
- There are no T&E species documented as inhabiting the Site and none were observed during the field investigation by MSE in June 2008, or during the site reconnaissance by MSE in October 2007.
- Federally listed T&E species which may occur within Grant County, Oregon include:
  - Canada lynx (Felis lynx Canadensis),
  - Bald eagle (Haliaeetus leucocephalus),
  - Steelhead, Middle Columbia River (Oncorhynchus mykiss ssp.), and
  - Bull trout, Columbia River Basin (Salvelinus confluentus).

1.3 Operational History

- Information regarding the operational history of the Pyx Mine is very limited. The available information is summarized below.
  - Once owned by Frank Stewart of Baker, Oregon (ODGMI 1941).
  - There were six unpatented claims for the area in 1941 (ODGMI 1941).
  - Development of the Site included a 150 foot deep shaft and several short adits (Brooks 1968):
    - There are two drifts.
    - A drift on the old Pyx claim was driven to 600 feet, and a drift on the new Pyx claim was driven to 150 feet.
    - The shaft is full of water (ODGMI 1941).
  - The Pyx Mine had a small amount of output before 1900 and from 1907 to 1911. A 25-ton mill was built in 1954, but it was rarely used (Brooks 1968).

1.4 Previous Investigations

- The Forest Service completed an Abbreviated Preliminary Assessment (APA) of the Site in March 2004.
- A portable X-ray fluorescence (XRF) analyzer was used to measure in-situ metals concentrations in waste rock and tailings at the Site.
  - Arsenic, chromium, and lead were the only contaminants of interest (COI) detected at concentrations exceeding EPA Region IX Industrial Soil Preliminary Remediation Goals (PRG, EPA 2004b).
  - The detection limit for some COIs may have been greater than the PRGs, resulting in false negatives.
- Based on the observed arsenic, chromium, and lead concentrations in the tailings, the APA recommended an SI be completed.

2.0 FIELD INVESTIGATION

- MSE conducted a field investigation of the Pyx Mine on June 20-21, 2008.
- Field investigation activities included:
  - Conducting a site reconnaissance to identify, inventory, and document the location and condition of mine waste sources and physical hazards
  - Completing a limited topographical survey of the Site
  - Collecting mine waste, background soil, surface water, and sediment samples
- Site photographs taken during the field investigation are provided in Appendix C.

2.1 Site Reconnaissance and Physical Hazards Survey

- Field staff inspected the Site and inventoried mine-related features, physical hazards, and other potential sources of contamination.
- Site features observed during the field investigation are shown on Figure 2 and include:
  - A partially collapsed adit,
  - One waste rock pile,
  - A tailings impoundment,
  - Remnants of a wooden mill structure, and
  - Miscellaneous wood and metal debris.
  - There is also reportedly a 150-foot deep flooded shaft at the Site that could not be located during the field investigation but may be under a large pile of wood and metal debris in front of the mill structure.
- The access road to the Site (FR 120) is well traveled and reasonably accessible to a 2-wheel drive vehicle.
  - The access road leads to a large waste rock pile (WR1) outside the partially collapsed adit.
  - The road continues about 400 feet around to the mill area.
  - A second road extends from the base of the waste rock pile along the mill area about 200 feet to the tailings impoundment.
- The main waste rock pile (WR1) covers an area of about 11,000 square feet (sf) and appears to consist of coarse waste rock with fine material along the face and toe.
- The partially collapsed adit is about 120 feet north of the access road across from the waste rock pile in a steep and narrow cut about 24 feet deep.
  - During the field investigation, water was discharging from the adit at < 1 gpm. The flow travels about 140 feet before infiltrating in the top of the waste rock pile.

- The waste rock pile appears to be a mixture of waste rock and native overburden or road cut, particularly close to the road. The pile extends down to and around the base of the wooden mill structure.
- The mill area covers about 5,000 sf and consists of a 12-foot by 16-foot wooden mill structure approximately 20-feet tall, a large concrete foundation (~180 sf), and a large pile of wood and metal debris.
- The remains of what appears to have once been a tailings conveyance channel leads to the tailings impoundment about 180 feet southwest of the mill area.
  - The channel ranges in width from about 2 to 6 feet, and 1 to 2 feet in depth.
  - Scattered thin deposits (1 to 6 inches) of tailings were observed in the channel bottom.
  - The tailings impoundment covers an area of about 4,000 sf and an earthen berm 1 to 3 feet high extends around the perimeter of the impoundment on both sides and the downslope end.
  - A dense stand of lodgepole pines is growing in the tailings and the area is well covered with organic matter and detritus.
  - A hand auger was used to measure the depth of tailings at four locations in the impoundment.
    - The depth of tailings ranged from 1.5 to 2.0 feet.
- Physical hazards at the Site pose a risk to the public and consist of a partially collapsed adit, a structurally unstable wooden mill frame, and possibly an open shaft.
  - The partially collapsed adit is highly visible, uncovered, and accessible to the public. There is also a risk of falling rock from the surrounding highwalls and steep slope.
  - There is a risk of the public climbing and falling from the wooden mill frame. Falling timbers pose another risk to those exploring the mill frame.
  - If the reported 150-foot deep flooded shaft is found, it could pose a significant drowning hazard to anyone falling into it.
- Two potential repository locations and soil borrow sources were identified downslope of the tailings impoundment and about 500 feet southwest of the mill area. One area is in the open meadow about 300 feet southwest of the tailings impoundment and the other area is in a wooded area about 100 feet northwest of the tailings impoundment. Both areas are easily accessible, have at least 1 acre of usable area, and have average slopes of 15 percent or less.

2.2 Site Mapping

- Cornerstone Surveying from John Day, Oregon was contracted to perform a limited topographical survey of the Site.
- Objectives of the survey were to collect sufficient topographic data points to:
  - Generate a 2-foot contour map of the Site
  - Delineate waste areas
  - Assist in estimating mine waste quantities
  - Locate key Site features and hazards
- The survey did not include locating or surveying property boundaries.
- No benchmark could be found on the Site; thus, a global positioning system (GPS) instrument was used to establish a temporary benchmark on the Site near the adit. An iron pin was driven into the ground and the location was recorded as being at 5,777.65 feet amsl, 2,408.4 feet south, and 1,152.8 feet east of the NW corner of Section 1.

2.3 Mine Waste Volume Estimation

- The topography and dimensions of each mine waste pile were surveyed to assist in estimating mine waste volumes; however, the estimated volumes do not account for potential contamination of underlying soils or "creep" (i.e. migration or spreading of the waste material via gravity, erosion, or other means). Therefore, the volumes listed below are estimates only and subject to verification.
  - The surface areas and estimated volumes of each mine waste pile are summarized in Table 2.
  - The estimated waste volumes were calculated by comparing an assumed underlying pre-mining topography to the existing topography using AutoCAD software.
  - The waste volumes are estimated based on comparing the topographic survey to the approximated pre-mining topography. The combined total estimated volume of mine waste at the Site is 4,230 bank cubic yards (bcy).
    - The estimated volume of waste rock pile WR1 is 3,200 bcy.
    - The estimated volume of contaminated soil around the mill foundation is 430 bcy.
    - The estimated volume of tailings in the channel between the mill and the tailings impoundment is 60 bcy.
    - The estimated volume of tailings in the impoundment is 540 bcy.
- The waste piles were inspected for evidence of flooding and erosion.
  - There was very little erosion along the steep side slopes of the waste rock pile and no significant rills were observed.
  - There was no evidence of an outflow from the tailings impoundment and, with exception of the conveyance channel leading to the impoundment, the tailings appear to be confined to the impoundment.
  - None of the mine waste areas are subject to flooding or erosion from stream flows.

2.4 Sample Collection

- Samples of mine waste, background soil, surface water, and sediment were collected from the locations shown on Figure 2 and are summarized in Table 3.
- Characterization samples consisted of:
  - Mine waste samples collected from:
    - Waste rock pile WR1
    - Waste rock and soil around the mill foundation
    - Soil from the tailings impoundment and conveyance channel
  - A surface water sample of adit discharge was collected from the pool in adit opening.
  - A sediment sample was co-located with the surface water sample and collected from the mouth of the adit.
- Background samples consisted of:
  - Soil samples collected from four undisturbed areas around the perimeter of the Site
  - No background sediment or surface water samples could be collected because there were no available background sources
- The sampling methods and procedures used for each medium are described in the following sections.

2.4.1 Background Soil

- Background soil samples were collected from four areas (BG1 through BG4) near the mine that did not appear to have been disturbed by mining or other activities.

- The selected areas are expected to be representative of background conditions for the Site.
- One grab sample was collected from each location at a depth of 6 to 12 inches bgs utilizing disposable plastic hand trowels.
- Background soil sample locations are shown on Figure 2.

2.4.2 Mine Waste

- A total of 15 mine waste characterization samples were collected:
  - Six grab samples were collected from the main waste rock pile WR1 (WR1-PX-G-01 through WR6-PX-G-01),
  - Four grab samples were collected from waste rock and soil around the mill area (WR7-PX-G-01 through WR10-PX-G-01), and
  - Five grab samples were collected from the tailings impoundment and conveyance channel (TA1-PX-G-01 through TA5-PX-G-01).
- A duplicate mine waste grab sample (WR8-PX-G-02) was collected from sample location WR8.
- The samples were all collected from depths ranging from 6 to 12 inches bgs using disposable plastic hand trowels.
- The mine waste characterization sample locations are shown on Figure 2.

2.4.3 Surface Water

- One surface water sample was collected from the adit discharge (SW-PX-G-01) using a peristaltic pump and Tygon® tubing.
- Sample bottles required for the dissolved metals analyses were filtered in the field using disposable Tygon® tubing, a peristaltic pump, and disposable 0.45-micron filters.
- Field parameters, summarized in Table 3, were measured during sample collection.
- Stream flow was visually estimated to be <1 gpm; there was insufficient flow to measure using the timed-volumetric method.
- The surface water sample location is shown on Figure 2.

2.4.4 Sediment

- One sediment sample was collected and co-located with the surface water sample:
  - The sediment sample (SD1-PX-G) was collected at the mouth of the adit at SW1.
- Gravel and bits of vegetation were removed from the sample in the field and the lab was instructed to screen the sediment sample and discard material greater than 2 millimeters in diameter to focus the analysis on the finer material.

3.0 PHYSICAL HAZARD ASSESSMENT

- Physical hazards identified at the Site during the field investigation consist of the following:
  - A partially collapsed adit,
  - A structurally unstable wooden mill frame, and
  - Possibly an open shaft.

3.1 Adit

- A partially collapsed adit was identified during the field investigation. The adit is highly visible from the road and easily accessible to the public; however, there was no evidence of traffic into the portal.
- The opening at the exposed wooden portal is approximately 4 feet wide by 1.5 feet high.
- Water was discharging from the adit at < 1 gpm during the field investigation.
- The adit does not appear to constitute a significant public hazard but may invite exploration or potential excavation of the area to expose more of the adit portal.
- The high walls (~24 feet) and steep slope (30° to 60°) around the adit pose a potential risk from collapse or falling rock.

3.2 Mill Frame

- The wooden mill frame is approximately 20 feet tall and a wooden ladder extends into the upper level.
- While the structure appears to be relatively stable, there is a risk from falling timbers. There is also a risk of the public climbing and falling from the structure.

3.3 Shaft

- There is reportedly a 150-foot deep flooded shaft on the Site that could not be located during the field investigation (ODGMI 1941).
- If present, the open shaft could pose a significant risk to the public.

4.0 ANALYTICAL RESULTS

- Solid and aqueous samples were submitted to SVL Analytical (SVL) in Kellogg, Idaho.
- Table 3 summarizes the samples and corresponding laboratory analyses.
    - Background soil sample analysis:
        - Paste pH
        - Selected metals typically found at mining sites in the region: antimony, arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, selenium, silver, and zinc
        - Arsenic speciation (one sample representing 20 percent of the total number of samples)
    - Mine waste samples:
        - Paste pH
        - Selected metals: antimony, arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, selenium, silver, and zinc
        - Total and weak acid dissociable (WAD) cyanide
        - Acid base accounting (ABA), sulfur forms, and metals by Synthetic Precipitation Leaching Procedure (SPLP) and Toxicity Characteristic Leaching Procedure (TCLP; only six samples representing 40 percent of the total number of samples)
        - Arsenic speciation (three samples representing 20 percent of the total number of samples)
    - Sediment sample:
        - Selected metals: antimony, arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, selenium, silver, and zinc
        - Total and WAD cyanide
        - Total organic carbon (TOC) and total carbon content
        - Arsenic speciation

- Surface water sample:
  - Total metals: arsenic, chromium, mercury, and selenium
  - Dissolved metals: antimony, arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, selenium, silver, and zinc
  - Total and WAD cyanide
  - Total dissolved solids (TDS)
  - Hardness, sulfate, and pH

- UCL_{90} concentrations were calculated using a spreadsheet developed by the Oregon Department of Environmental Quality (ODEQ).
  - Available online at http://www.deq.state.or.us/lq/tanks/lust/upperconfidencelimit.htm.
  - Equations used in the spreadsheet are based on procedures described in EPA's *"Supplemental Guidance to RAGS: Calculating the Concentration Term"* (EPA 2002).
  - The program computes UCLs for each data set using several methods and recommends one based on the data distribution.
  - Data sets with fewer than 10 data samples can provide statistically unreliable estimates of the true average and the estimated UCL_{90} may occasionally exceed the maximum detected concentration (MDC). In those instances, the MDC was used in place of the UCL_{90}.

4.1 Background Soil

- Analytical results of the background soil samples are presented in Table 4.
  - Silver, antimony, and selenium were not detected in any of the background soil samples.
  - Several COIs detected in the background soil samples exceeded human health and/or ecological screening criteria:
    - The arsenic UCL_{90} (5.7 mg/kg) exceeded the EPA Region IX Industrial Soil PRG of 1.6 mg/kg (EPA 2004b) and the Oregon Industrial Maximum Allowable Soil Concentration Cleanup Level of 3.0 mg/kg (ODEQ 2000b).
    - The UCL_{90} of iron and zinc both exceeded Oregon Level II Screening Level Values (SLV) for Plants, Invertebrates, and Wildlife (ODEQ 2001).
    - The UCL_{90} for cadmium exceeded the EPA Ecological Soil Screening Level (Eco-SSL) of 0.36 mg/kg (EPA 2005).
  - Selenium and antimony were reported as not detected; however, the laboratory reporting limit (RL) for selenium was above the SLV, and the RL for antimony was above the Eco-SSL.
    - The RL is the lowest concentration at which an analyte can be detected in a sample and its concentration can be reported with a reasonable degree of accuracy and precision.
    - When the RL is above the SLV, a sample result reported as not detected (i.e. below the RL) may still be present at a concentration above the SLV but cannot be verified.

4.2 Mine Waste

- Analytical results of the mine waste samples are presented in Tables 5 and 6.
  - Most COI concentrations were elevated above background levels when compared to background soil UCL_{90}.
  - Arsenic, mercury, and lead exceeded human health screening criteria.
    - Arsenic concentrations ranged from not detected (i.e. <2.5 mg/kg) to 364 mg/kg, with the highest concentrations in samples from the tailings impoundment.
    - Arsenic in all but one sample (WR3-PX-G-01) exceeded the EPA Region IX Industrial Soil PRG (1.6 mg/kg, EPA 2004b) and Oregon Industrial Maximum Allowable Soil Concentration Cleanup Level (3.0 mg/kg, ODEQ 2000b).

- Mercury concentrations ranged from not detected (i.e. <0.035 mg/kg) to 375 mg/kg; however, the maximum detected mercury concentration of 375 mg/kg in sample WR9-PX-G-01 is more than two orders of magnitude higher than reported in any other sample and may be an anomaly.
- The maximum detected mercury concentration of 375 mg/kg in sample WR9-PX-G-01 exceeds the EPA Region IX Industrial Soil PRG of 310 mg/kg (EPA 2004b).
- Lead concentrations ranged from 3.1 mg/kg to 1,210 mg/kg.
- Lead concentrations in two tailings samples (TA2-PX-G-01 and TA3-PX-G-01) exceeded the EPA Region IX Industrial Soil PRG of 800 mg/kg (EPA 2004b), but were below Oregon's Industrial Maximum Allowable Soil Concentration Cleanup Level of 2,000 mg/kg (ODEQ 2000b).

- Nearly all COIs exceeded one or more ODEQ and EPA ecological screening criteria.
  - Oregon Level II SLV for Plants, Invertebrates and Wildlife (ODEQ 2001):
    - All samples exceeded the iron SLV.
    - Thirteen samples exceeded the cadmium SLV.
    - Eleven samples exceeded the lead SLV.
    - Nine samples exceeded the zinc SLV.
    - Seven samples exceeded the copper SLV.
    - Seven samples exceeded the mercury SLV.
    - Three samples exceeded the nickel SLV.
    - One sample exceeded the selenium SLV.
  - EPA Eco-SSLs (EPA 2005):
    - All samples exceeded the cadmium Eco-SSL.
    - Seven samples exceeded the arsenic Eco-SSL.
    - Eleven samples exceeded the lead Eco-SSL.
- Several results were reported as not detected; however, the RLs were above one or more screening criteria which means the constituents may still be present at a concentration above the SLV but cannot be verified.
- The TCLP and SPLP results are summarized in Table 6.
  - All results were well below the Resource Conservation and Recovery Act (RCRA) disposal limits which indicates that meteoric precipitation (i.e. rain and snow) that percolates through the mine waste is not likely to leach metals from the material and into groundwater.

4.3 Acid Base Accounting

- ABA testing predicts the potential for acid to be generated, based on the sulfur and carbonate content of the mineral (EPA 1994).
  - In ABA, a sample's Acid Generating Potential (AGP) is calculated from its pyritic sulfur (i.e., sulfide) content and the Acid Neutralization Potential (ANP) is measured from its ability to react with acid. The result is known as the Net Neutralization Potential (NNP) and is reported in tons of calcium carbonate ($CaCO_3$) per 1,000 tons of soil.
    - Negative NNP values indicate a risk of acid generation.
    - Values of NNP less than -20 indicate a material is likely to generate acid and values greater than +20 indicate the material is unlikely to generate acid.
    - Values between -20 and +20 fall into a zone of uncertainty and kinetic testing is required to predict acid generation potential.
    - ANP/AGP ratios greater than 3 represent a low risk and ratios less than 1 represent a high risk of acid generation.

    - Ratios between 1 and 3 fall into a zone of uncertainty. It should be noted that the accuracy of ABA can be adversely affected by the presence of acid-producing sulfate minerals, iron or magnesium carbonates, or metals which form hydroxide precipitates.
    - In general, total sulfur content greater than 0.5 percent indicates risk of acid generation.
- To estimate the potential for acid generation from mine waste at the Site, ABA tests were conducted on six mine waste samples:
    - Two waste rock samples from WR1.
    - Two waste rock samples from waste rock and soil around the mill.
    - Two tailings samples – one from the conveyance channel and one from the impoundment.
- The ABA results, summarized in Table 5, indicate a very low potential for acid generation in the mine waste.
    - NNP values ranged from 0.6 to 7.5, and the ANP/AGP ratios ranged from 2 to 35 indicating a low risk of acid generation.
    - Mine waste pH was only slightly acidic and ranged from 5.20 to 6.97.
    - Total sulfur content in all samples was 0.03 percent or less, which indicates a very low potential for acid generation.

4.4 Sediment

- Analytical results of the sediment sample are presented in Table 7.
    - Silver, cadmium, antimony, and selenium were not detected in the sample.
    - Arsenic was the only COI that exceeded human health screening criteria.
        - Exceeded both the ODEQ Industrial Maximum Allowable Soil Concentration (3.0 mg/kg, ODEQ 2000b) and the EPA Region IX Industrial Soil PRG (1.6 mg/kg, EPA 2004b).
    - Several COIs exceeded ecological screening criteria:
        - Copper, nickel, and zinc exceeded Oregon Level II SLVs (ODEQ 2001).
        - Nickel also exceeded the NOAA Threshold Effects Level (TEL), which is defined as the concentration below which adverse biological effects are not expected to occur (NOAA 1999). However, the result was below the NOAA Probable Effects Level (PEL) which is defined as the concentration above which adverse biological effects are frequently expected to occur (NOAA 1999).
    - The results for arsenic III, cadmium, and selenium were reported as not detected; however, the RLs were above the Oregon Level II SLVs which means the constituents may still be present at a concentration above the SLV but cannot be verified.
    - TOC was 0.04 percent and total organic matter (TOM) was 0.7 percent. These values are very low but are consistent with the seasonal and extremely low flow conditions of the adit discharge.

4.5 Surface Water

- Analytical results of the single surface water sample are presented in Table 8.
    - Besides the major cations (calcium and magnesium), the only COIs detected were sulfate, copper and iron.
    - The results for arsenic and mercury were reported as not detected; however, the RLs were above one or more screening criteria which means the constituents may still be present at a concentration above the SLV but cannot be verified.
    - The pH was 7.19, hardness was 51.9 milligrams per liter (mg/L) $CaCO_3$, and TDS was 95 mg/L.

4.6 Data Quality Review

- SVL Analytical conducted quality assurance (QA) consistent with the published methods, in accordance with its Quality Assurance Plan.
  - Internal QA procedures included the use of method blanks and laboratory control samples (LCS).
    - A method, or laboratory, blank is a sample of an uncontaminated reference matrix. The laboratory blank is analyzed to evaluate the accuracy of the analysis.
    - Laboratory control samples are evaluated to assess overall method performance and are the primary indicators of laboratory performance.
    - In addition, MSE submitted selected samples for matrix spike/matrix spike duplicate (MS/MSD) analysis.
    - In the MS/MSD analysis, the laboratory spikes two portions of the raw sample with a known amount of each analyte, then subjects the spiked and unspiked samples to the entire analytical procedure.
  - The percent recovery (%R) and relative percent difference (RPD) results from these samples allow an assessment of both the accuracy and precision of the combined sampling/analytical system.
- MSE also collected field duplicate samples to externally estimate sampling and analytical precision.
  - A field duplicate is a sample collected in the field at exactly the same time and location as another sample.
  - In practice, the duplicate is often a "split sample" (a portion of the original sample transferred to a separate sample bottle at the time of collection).
  - The field blank consisted of distilled, analyte-free water poured into laboratory-supplied samples containers in the field during sample collection.
- Review of SVL data quality:
  - Internal QA:
    - Method blanks: the concentrations of all analytes in each method blank were below the RLs, except for iron, which was detected at a concentration of 7.3 mg/kg in one of the blanks.
    - Laboratory control/laboratory duplicate samples (LCS/LCSD): the reported %Rs and RPDs for all the LCS/LCSD pairs were within the laboratory QC limits except for calcium, ANP, and total sulfur, which were outside the RPD limits.
    - MS/MSD samples: the results for the MS/MSD pairs showed recoveries outside of the acceptance limits for antimony, arsenic (III), cyanide (total), iron, and zinc.
    - Sample holding times: the sample holding time for the analysis of cyanide (total and WAD) was exceeded in all samples; however, as cyanide was not detected in any of the samples, MSE does not believe further sampling and analysis is necessary.
  - External QA:
    - Field duplicates: a duplicate of a grab sample collected from the waste rock pile (WR8-PX-G-01) was submitted to SVL for analysis.
      - The RPDs between concentrations of metals measured in grab soil sample WR8-PX-G-01 and duplicate sample WR8-PX-G-02 ranged from 0 to 45 percent.
- Overall review of SVL's data quality results indicate that the analytical system was "in control" and that the reported concentrations are suitable for use in the SI and the streamlined risk assessments.

5.0 STREAMLINED RISK ASSESSMENT SUMMARY

- Streamlined human health and ecological risk assessments were completed for the Site and are provided in Appendix B and summarized in the following sections.
- The streamlined risk assessments focus on and evaluate only the principal exposure pathways and significant targets of concern. The objective is to determine whether sufficient risk is present to warrant a removal action.
- The streamlined process is intended to eliminate unnecessary data development and analysis, and reduce the overall effort and cost of the removal action. This approach recognizes that the elimination of all uncertainties is not possible or necessary, and uses only the data needed to generally characterize potential risks at the Site and support the development and selection of removal action alternatives.

5.1 Initial Risk Screening Summary

- The streamlined risk assessments included an initial risk screening as a very simplified risk evaluation to determine if further assessment was warranted. The initial screening involved comparing the maximum detected COI concentrations to U.S. Bureau of Land Management (BLM) Risk Management Criteria (RMC) for a preliminary qualitative assessment of potential risk to human and ecological receptors at the Site (Ford 2004).
  - The RMCs were developed as a screening tool for quickly assessing overall risks to humans and wildlife at abandoned mining sites from exposure to the most problematic metals (antimony, arsenic, cadmium, copper, lead, manganese, mercury, nickel, selenium, silver, zinc) typically found at abandoned mine sites.
  - The human health RMCs for soil, sediment, and surface water are based on exposure scenarios that could potentially occur at abandoned mine sites, including camper, all-terrain vehicle driver, worker, surveyor, boater, swimmer, and resident. The camper scenario RMCs were used for the Pyx Mine.
    - Arsenic, lead and mercury in the mine waste samples exceeded human health RMCs.
    - Lead poses a moderate risk, and arsenic and mercury pose a high risk to human receptors at the Site.
    - There does not appear to be a human health risk from exposure to surface water or sediment at the Site.
  - The ecological RMCs were developed for soil from a survey of literature for toxicity data relevant to either wildlife receptors at BLM sites or to closely related species (Ford 2004).
    - The initial screening results indicate moderate to extremely high risk to all receptors from exposure to arsenic, cadmium, lead and mercury in the mine waste.
    - Copper poses a moderate risk to the mule deer and a high risk to the robin.
    - Zinc poses a moderate risk to the robin.
    - There is also moderate risk to the robin from exposure to cadmium, copper and zinc in the background soil.

5.2 Human Health Risk Summary

- A streamlined human health risk assessment (HHRA) was conducted to assess and evaluate potential risks associated with exposure to mining-related contaminants at the Site (MSE 2008).
- The HHRA evaluated potential impacts to human health resulting from exposure to site-related contaminants of potential concern (COPC) in mine waste, sediment, and surface water at the Site.

- The results were used to identify areas and media posing significant risks to potential human receptors at the Site. Both reasonable maximum exposure (RME) and central tendency exposure (CTE) scenarios were evaluated.
- Three COPCs were identified: arsenic, lead and mercury. Arsenic (inorganic) is a known carcinogen and lead is a probable carcinogen. All three COPCs can pose non-carcinogenic health risks at high concentrations.
- The estimated non-carcinogenic hazards and carcinogenic risks from exposure to COPCs at the Site are summarized in Table 9.
  - The non-carcinogenic hazard indices (HI) from exposure to arsenic and mercury were below 1 for all receptors under both the CTE and RME scenarios.
  - The carcinogenic risk to all receptors from exposure to arsenic under the CTE scenario was < 1.E-06.
  - Under the RME scenario, there is a moderate carcinogenic risk to all receptors from exposure to arsenic.
    - The total cumulative excess cancer risk (ECR) was 1.E-05 for the child recreationalist and 8.E-06 for the adult recreationalist.
    - The highest carcinogenic risk was to the adult worker with a total cumulative ECR of 8.E-05.
  - Risks from exposure to lead cannot be quantified using standard risk assessment algorithms because the EPA has not established lead RfDs and SFs. Therefore, lead risks were qualitatively evaluated by comparing the maximum detected lead concentrations at the Site to EPA and Oregon State human health screening criteria.
    - Two mine waste samples from the tailings impoundment contained lead concentrations above EPA's Industrial Soil PRG (800 mg/kg, EPA 2004b); however, both samples were well below Oregon's Industrial Maximum Allowable Soil Concentration Cleanup Level (2,000 mg/kg, ODEQ 2000b).
    - Lead does not appear to pose a human health risk at the Site.
- Incidental ingestion of and dermal contact with arsenic in the mine waste are the most significant exposure pathways and contribute the majority of carcinogenic risk at the Site.
  - Dermal contact with and incidental ingestion of surface water and sediment, and inhalation of particulates from the mine waste contributed minimally to the overall risk and, therefore, are not considered to be significant exposure pathways at the Site.

5.2.1 Hot Spot Assessment

- Hot spots are defined by Oregon's Environmental Cleanup Rules (OAR 340-122) as areas that present unacceptable risk and where contamination is "highly concentrated, highly mobile, or cannot be reliably contained."
  - "Highly concentrated" is defined as concentrations corresponding to a non-carcinogenic HQ of 10 or an ECR of 1E-04 (ODEQ 1998).
  - Hot spots often cover a relatively small area but contribute to a large percentage of the overall site contamination and exposure risk.
- A hot spot concentration for arsenic in mine waste was back-calculated using the HHRA risk equations and an ECR of 1.E-04 and non-cancer HI of 10 for the most sensitive receptor (adult worker) under the RME scenario.
  - Soil arsenic hot spot concentration calculated to be 460 mg/kg
- None of the mine waste samples exceeded the hot spot concentration and no hot spots were identified at the Site.
- Results of the hot spot assessment are summarized in Table 10.

5.2.2 Risk-based Cleanup Levels

- Because results of the HHRA indicated potential significant human health risks at the Site, a risk-based cleanup level was developed for arsenic in mine waste at the Site.
- The risk-based arsenic cleanup level was back-calculated using the same equations and site-specific exposure factors used in the HHRA to calculate human health risks at the Site.
  - Risk equations for the most sensitive receptor (adult worker) under the RME scenario were used and an ECR of 1.E-05 was entered into the equations to back-calculate the corresponding maximum allowable arsenic concentration (i.e. cleanup level).
  - Soil arsenic cleanup level = 46 mg/kg
    - A total of five mine waste samples from two different areas exceeded the soil cleanup level:
      - Waste rock pile WR1, maximum detected arsenic concentration = 62.9 mg/kg
      - Tailings impoundment, maximum detected arsenic concentration = 364 mg/kg
      - Estimated volume of mine waste above cleanup level = 3,740 bcy
- No cleanup levels were established for sediment because of the low arsenic concentration (5.4 mg/kg) measured in the single sediment sample.
- No cleanup levels were established for surface water because they typically default to state or federal water quality criteria, such as EPA maximum contaminant levels (MCL), and surface water does not pose a human health risk at the Site.
- Areas exceeding the cleanup levels are summarized in Table 10.

5.3 Ecological Risk Assessment Summary

- A screening level streamlined ecological risk assessment (ERA) was conducted to assess and evaluate potential ecological risks associated with exposure to mining-related contaminants at the Site. The ERA evaluated potential impacts to ecological receptors resulting from exposure to site-related contaminants in mine wastes, sediment, and surface water.
- The streamlined ERA involved identifying potential contaminants of ecological concern (CPEC) and calculating ecological risk ratios for ecological receptors in each medium. The risk ratios were then compared to receptor-specific risk ratios (Q-factors) to evaluate potential ecological risk.
- Risk ratios greater than 1 (Q > 1) indicate potential risk for protected (i.e., federally listed T&E species) while risk ratios greater than 5 (Q > 5) indicate potential risk to non-protected receptors. An acceptable risk ratio of Q = 5 was used in this streamlined ERA because, although T&E species have been identified in the Wallowa-Whitman National Forest, there appears to have been no documented occurrences at the Site and none were observed during the field investigation.
- COIs with risk ratios of Q > 5 were retained as CPECs. Several COIs also were retained because of the lack of established SLVs; the potential ecological risk posed by these CPECs, if any, cannot be quantified.
- Five CPECs were identified with risk ratios of Q > 5: iron, lead, mercury, selenium, and zinc.
  - Five additional CPECs were identified based on the lack of SLVs: antimony, arsenic V, arsenic total, chromium, and silver.
- Results of the streamlined ERA indicate potential risk to ecological receptors at the Site and are summarized in Table 11.
  - Ecological risks from mine waste:
    - Mercury poses a high risk to plants (Q = 1,250), high risk to terrestrial invertebrates (Q = 3,750), and a moderate risk to birds (Q = 100). However, it's important to note that these

results are skewed by an unusually high mercury concentration in one sample (WR9-PX-G-01).
    - Iron also poses a high risk to plants (Q = 2,850) and moderate risk to terrestrial invertebrates (Q = 143).
    - Lead also poses a risk to plants (Q = 24) and birds (Q = 65).
    - Selenium poses a low risk to plants (Q = 6).
  - Ecological risks from sediment:
    - Zinc poses a bioaccumulation risk to aquatic life (Q = 11).
  - Risk ratios from exposure to surface water were all less than Q = 5.
  - Risk ratios for mammals were all less than Q = 5.
  - Plants and terrestrial invertebrates are the most susceptible ecological group with the highest risk ratios.
- Ecological risks appear to be limited to individual receptors and there does not appear to be any significant population-level risks.

6.0 CONCLUSION AND RECOMMENDATIONS

- Analytical results of samples collected during the field investigation indicate elevated concentrations of several metals in the mine waste.
- Metals concentrations in the background soil samples were significantly lower and nearly all metals were undetected in the surface water sample.
- Potential acid generation in the mine waste is very low.
- There is no obvious evidence of contaminant migration from the Site.
- Results of the streamlined HHRA indicate significant risk from exposure to arsenic in mine waste and at the Site.
  - Two human health COPCs were identified: arsenic and mercury.
  - Arsenic poses carcinogenic risk to all three receptor groups under the RME scenario.
  - The most significant exposure pathway is incidental ingestion of and dermal contact with the mine waste.
  - Inhalation of particulates from the mine waste, and incidental ingestion of and dermal contact with surface water and sediment contribute minimal risk and are insignificant pathways.
- Results of the streamlined ERA indicate significant potential risk to ecological receptors at the Site; however, the risks are limited to individual receptors rather than at the population level.
  - Several CPECs were identified and the highest risk ratios are for metals in the mine waste, particularly iron, lead and mercury.
  - There also appears to be limited bioaccumulation risk to individual aquatic receptors at the Site from exposure to zinc concentrations in sediment; however, aquatic species are expected to be minimal because of the intermittent nature of the adit discharge and low flow rate.
- There does not appear to be a significant human health or ecological risk from exposure to surface water or sediment at the Site.
- A risk-based cleanup criterion for arsenic in mine waste was back calculated using the exposure factors (EF) and risk equations used in the streamlined HHRA.
  - Based on the most sensitive receptor (adult worker) under the RME scenario and a cleanup carcinogenic risk level of 1.E-05 for total cumulative risk, the soil arsenic cleanup level is 46 mg/kg.
  - Five mine waste/soil samples from two areas exceeded the arsenic cleanup level: waste rock pile WR1 and the tailings impoundment.
  - The total volume of mine waste and soil exceeding the cleanup level is estimated to be 3,740 bcy:

- Waste rock pile WR1 = 3,200 bcy
- Tailings impoundment = 540 bcy

- Physical hazards at the Site consist of a partially collapsed adit, a wooden mill structure, and potentially an open shaft.
- Based on the results of this SI, MSE recommends performing a streamlined Engineering Evaluation/Cost Analysis (EE/CA) to address physical hazards at the Site and arsenic concentrations in the mine waste.

DISCLAIMER

This abandoned mine/mill Site was created under the General Mining Law of 1872 and is located solely on National Forest System (NFS) lands administered by the Forest Service. The United States has taken the position and courts have held that the United States is not liable as an "owner" under CERCLA Section 107 for mine contamination left behind on NFS lands by miners operating under the 1872 mining law. Therefore, Forest Service believes that this Site should not be considered a "federal facility" within the meaning of CERCLA Section 120 and should not be listed on the Federal Agency Hazardous Waste Compliance Docket. Instead, this Site should be included on EPA' CERCLIS database. Consistent with the June 24, 2003 OECA/FFEO "Policy on Listing Mixed Ownership Mine or Mill Sited Created as a Result of the General Mining Law of 1872 on the Federal Agency Hazardous Waste Compliance Docket," we respectfully request that the EPA Regional Docket Coordinator consult with the Forest Service and EPA Headquarters before making a determination to include this Site on the Federal Agency Hazardous Waste Compliance Docket.

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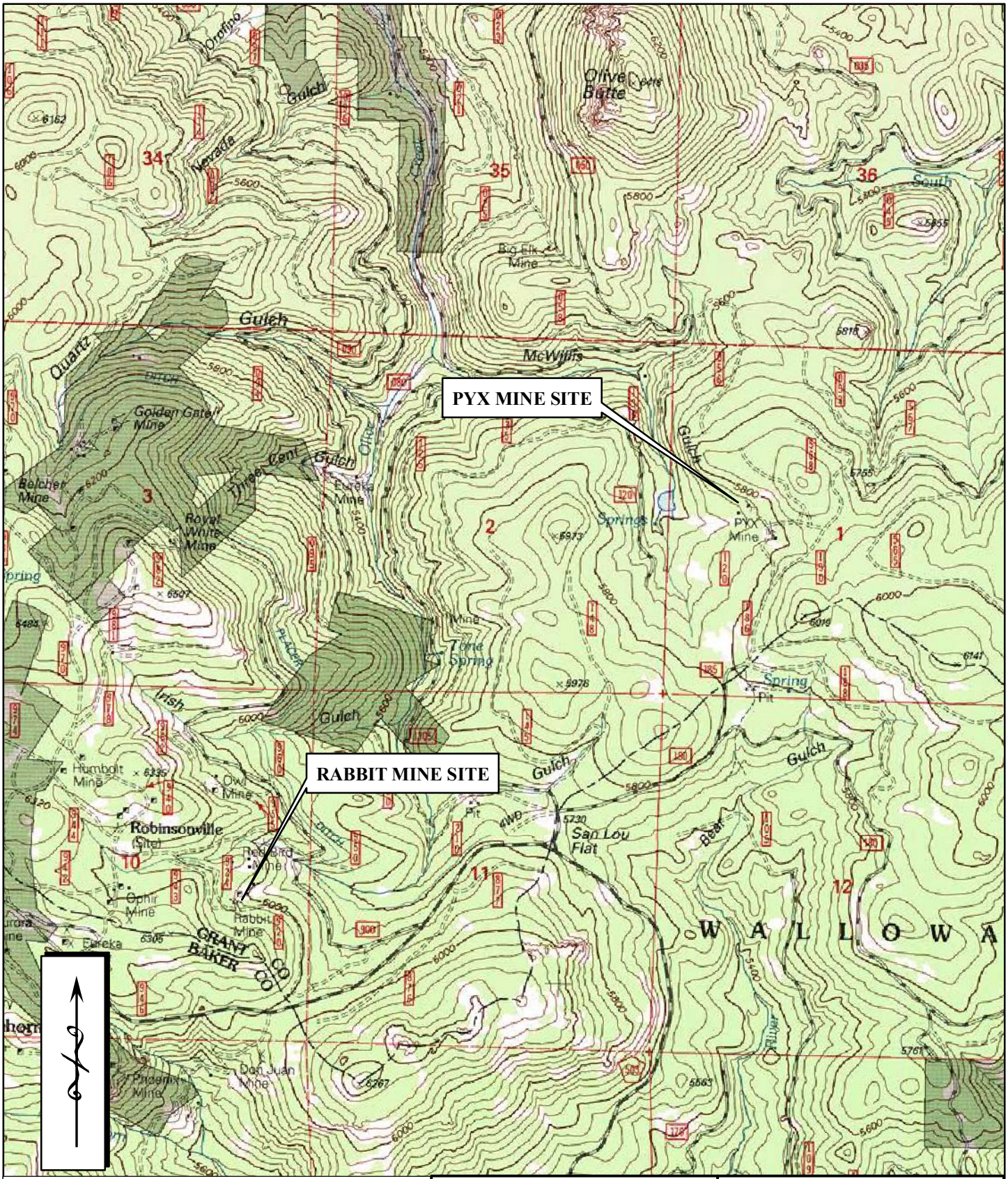
FIGURES



0 500 1,000 2,000 3,000 4,000 Feet

SCALE: 1 inch equals 2,000 feet

REFERENCE: U.S.G.S. 7.5 MINUTE QUADRANGLE, GREENHORN, OREGON 1995

MSE Millennium Science & Engineering, Inc.
1555 Shoreline Drive, Suite 150
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Pyx Mine Vicinity Map

B2473.H	pyx_rabbit.mxd	12/15/08	Figure 1

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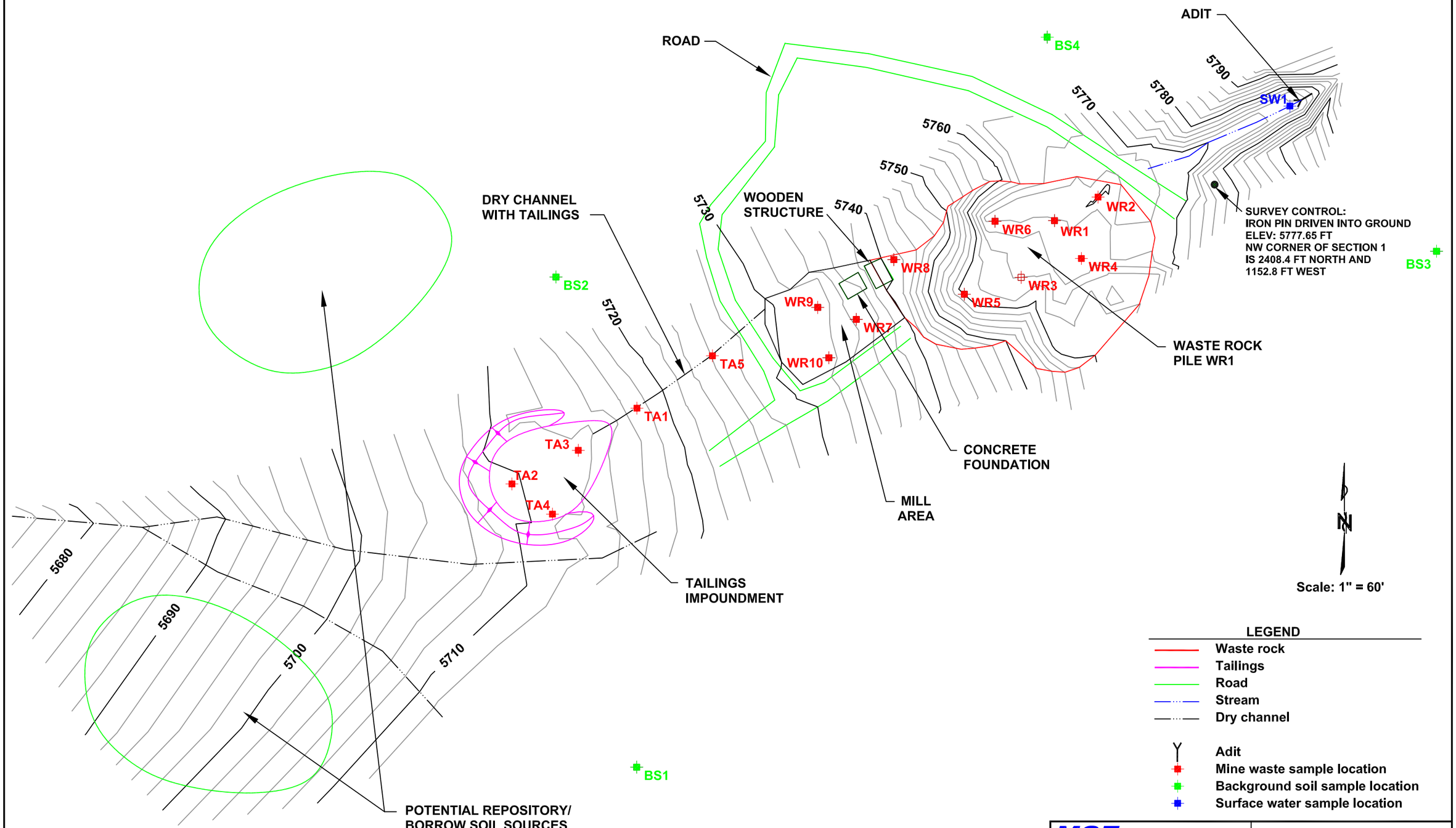

Base Map Source: Cornerstone Surveying, Inc. 6/23/08

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Pyx Mine Site Map

B2473G	figure2.dwg	2/6/09	Figure 2

TABLES

TABLE 1
Monthly Climatic Averages for Granite, Oregon WSW
Pyx Mine Site Inspection

Parameter	Month												Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Average Maximum Temperature (°F)	30.3	36.4	40.1	49	58	66.2	77.58	76.2	68.9	55.8	40	32.2	52.6
Average Minimum Temperature (°F)	11.3	15.1	17	25.3	31.4	36.6	39.3	38.4	33.8	28.8	21.5	15.6	26.2
Average Total Precipitation (in)	3.66	2.93	2.73	1.87	2.33	1.76	0.6	0.71	1.08	1.93	2.93	3.84	26.37
Average Total Snowfall (in)	40.6	31.5	29.7	10.5	3.9	0.6	0.0	0.0	0.7	3.7	17.5	35.4	174.1
Average Snow Depth (in)	28	35	35	16	1	0	0	0	0	0	3	14	11

Notes:
Source: National Weather Service, Period of Record 7/02/48 to 10/16/67 (WRCC 2008)
Percent of possible observations for period of record: maximum temperature = 99.3%, minimum temperature = 99.2%, precipitation = 99.4%, snowfall = 99.1%, snow depth = 98.6%
°F = Degrees Fahrenheit
in = inches

TABLE 2
Summary of Mine Waste Volumes and Selected Metal Concentrations
Pyx Mine Site Inspection

					Selected Maximum Detected Concentrations (mg/kg)			
Media	**Area**	**Description**	**Approximate Area (sf)**	**Estimated Volume (bcy)**	**Arsenic**	**Cadmium**	**Lead**	**Zinc**
Background Soil	BS1 - BS4	Undisturbed areas	NA	NA	7.7	1.5	7.7	82.4
Waste Rock	WR1	Main waste rock pile	16,000	3,200	63	3	208	114
	Mill area	Soil around mill frame and foundation	9,300	430	14	10	28	135
Tailings	Tailings conveyance channel	Channel from mill to tailings impoundment	560	60	28	1	60	70.1
	Tailings impoundment	Tailings impoundment	3,800	540	364	5	1,210	61.3
		Total Estimated Volume of Mine Waste =		**4,230**				

Notes:
bcy = Bank cubic yard
mg/kg = Milligram per kilogram
sf = Square foot
NA = Not applicable

TABLE 3
Field Investigation Sample Summary
Pyx Mine Site Inspection

Medium	Description	Number of Samples	Sample ID	Laboratory Analysis	Field Parameters
Waste Rock	Single grab sample from the waste rock pile	10 Grab	WR1-PX-G-01 Through WR10-PX-G-01	All samples analyzed for pH, metals[(a)], total & WAD CN 20% (2 of 10 samples) also analyzed for As speciation 40% (4 of 10 samples) also analyzed for ABA, SPLP, and TCLP	Description
Tailings	Single grab samples from the tailings impoundment	5 Grab	TA1-PX-G-01 Through TA5-PX-G-01	All samples analyzed for pH, metals[(a)], total & WAD CN 20% (1 of 5 samples) also analyzed for As speciation 40% (2 of 5 samples) also analyzed for ABA, SPLP, and TCLP	Description
Background Soil	Single grab sample from four different locations representative of background conditions	4 Grab	BS1-PX-G-01 Through BS4-PX-G-01	All samples analyzed for pH and metals[(a)] 20% (1 of 4 samples) also analyzed for As speciation	Description
Solids QA/QC	Field duplicate of mine waste sample	1 MS/MSD	WR-PX-G-01-MSD	pH and metals[(a)]	None
Sediment	Grab sample of sediment from the surface water sample location	1 Grab	SD1-PX-G-01	Analyzed for pH, metals[(a)], total & WAD CN, TOC, As speciation	Description
Surface Water	Water discharging from the adit	1 Grab	SW1-PX-U-01	Analyzed for total As, Cr, Hg, Se; sulfate; total & WAD CN; TDS; hardness; and pH	pH, temp., DO, EC, ORP/Eh
			SW1-PX-F-01	Dissolved metals[(a)]	

Notes:

[a]Antimony, arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, selenium, silver and zinc.
ABA = Acid base accounting
CN = Cyanide
DO = Dissolved oxygen
EC = Electrical conductivity
Eh = Redox potential
MS/MSD = Matrix spike/matrix spike duplicate
ORP = Oxygen reduction potential
QA/QC = Quality assurance/quality control
SPLP = Synthetic Precipitate Leaching Procedure
TCLP = Toxicity Characteristic Leaching Procedure
TDS = Total dissolved solids
Temp = Temperature
TOC = Total organic carbon
WAD = Weak acid dissociable

TABLE 4
Background Soil Analytical Results Summary
Pyx Mine Site Inspection

Sample ID	Date Collected	Solids (%)	Paste pH	Analyte Concentration (mg/kg)													
				Ag	As_3	As_5	As_T	Cd	Cr_T	Cu	Fe	Hg	Ni	Pb	Sb	Se	Zn
BS1-PX-G-01	6/21/2008	65.6	5.91	*0.25*	*7.5*	*7.7*	0.5	0.21	22.5	12	10100	0.0165	10.6	4.18	*1.0*	*2.0*	24.2
BS2-PX-G-01	6/21/2008	65.6	6.74	*0.25*	NA	NA	2.8	0.74	6.5	11.9	10200	0.035	10.7	4.61	*1.0*	*2.0*	74.1
BS3-PX-G-01	6/21/2008	66.2	6.59	*0.25*	NA	NA	*1.3*	0.75	5.3	11.5	9890	0.038	12.2	4.28	*1.0*	*2.0*	82.4
BS4-PX-G-01	6/21/2008	73.8	6.78	*0.25*	NA	NA	7.7	1.51	8.8	15.4	13200	0.048	19.3	7.65	*1.0*	*2.0*	73.0
minimum =		65.6	5.91	*0.25*	*7.5*	*7.7*	0.5	*0.21*	5.27	11.5	9890	0.017	10.6	4.18	*1.0*	*2.0*	24.2
MDC =		**73.8**	**6.78**	***0.25***	***7.5***	***7.7***	**7.7**	**1.51**	**22.5**	**15.4**	**13200**	**0.048**	**19.3**	**7.65**	**1.0**	***2.0***	**82.4**
average =		67.8	6.51	*0.25*	*7.5*	*7.7*	3.1	0.80	10.8	12.7	10848	0.034	13.2	5.18	1.0	*2.0*	63.4
90% UCL[a] =		NC	NC	*0.25*	NC	NC	5.7	1.24	17.3	14.4	12300	0.045	16.6	7.09	1.0	*2.0*	85.1
# of samples = 4; Standard Deviation =		NC	NC	0.00	0.0	0.0	2.8	0.46	6.9	1.6	1363	0.011	3.6	1.43	0.0	0.0	22.9
Frequency detected =		NC	NC	0%	0%	0%	75%	100%	100%	100%	100%	100%	100%	100%	0%	0%	100%
Human Health Screening Criteria																	
Oregon Industrial Maximum Allowable Soil Concentration Cleanup Levels (ODEQ 2000b)				10000	NS	NS	3	1000	1500	80000	NS	600	40000	2000	NS	NS	NS
EPA Region IX Industrial Soil PRGs (EPA 2004b)				5100	NS	NS	1.6	450	450	41000	100000	310	20000	800	410	5100	100000
Ecological Screening Criteria																	
Oregon Level II Screening Values for Plants, Invertebrates, and Wildlife (ODEQ 2001)				2	10	NS	NS	4	NS	50	10	0.1	30	16	5	1	50
EPA Ecological Soil Screening Levels (Eco-SSLs) (EPA 2005)				NS	NS	NS	18	0.36	NS	NS	NS	NS	NS	11	0.27	NS	NS

Notes:
Italics - result below laboratory reporting limit (RL), value = 1/2 RL.
Screening criteria exceeded.
[a]The MDC was used when the 90% UCL could not be calculated.
mg/kg = Milligram per kilogram
EPA = U.S. Environmental Protection Agency
MDC = Maximum detected concentration
NA = Not analyzed
NC = Not calculated
NS = No screening criteria
ODEQ = Oregon Department of Environmental Quality
PRG = Preliminary remediation goal
UCL = Upper confidence limit

TABLE 5
Mine Waste Analytical Results Summary
Pyx Mine Site Inspection

Area	Sample ID	Date Collected	Solids (%)	Paste pH	Analyte Concentration (mg/kg)															Sulfur Forms				ABA			
					CN (WAD)	CN (TOT)	Ag	As_3	As_5	As_T	Cd	Cr_T	Cu	Fe	Hg	Ni	Pb	Sb	Se	Zn	Pyritic (%)	Sulfate (%)	Non-extractable (%)	Total (%)	AGP ($TCaCO_3$/kT)	ANP ($TCaCO_3$/kT)	NNP ($TCaCO_3$/kT)	ANP/AGP Ratio
Waste Rock Pile WR1	WR1-PX-G-01	6/20/2008	89.3	5.63	*0.250*	*0.25*	*0.25*	NA	NA	62.9	1.73	3.36	82.8	11800	*0.017*	4.78	26.9	*1.0*	*2.0*	27.8	*NA*	*NA*	*NA*	*NA*	*NA*	NA	NA	NA
	WR2-PX-G-01	6/20/2008	89.5	5.23	*0.250*	*0.25*	*0.25*	NA	NA	60.8	2.59	3.1	96	15300	0.043	11.4	49.60	*1.0*	*2.0*	55.2	*NA*	*NA*	*NA*	*NA*	*NA*	NA	NA	NA
	WR3-PX-G-01	6/20/2008	74	6.2	*0.250*	*0.25*	*0.25*	NA	NA	*1.3*	0.77	18.7	40.4	28500	0.052	29.3	3.10	*1.0*	*2.0*	39.9	NA	NA	NA	NA	NA	NA	NA	NA
	WR4-PX-G-01	6/20/2008	73.6	6.42	*0.250*	*0.25*	*0.25*	NA	NA	2.5	0.81	18.6	38.7	28100	0.05	33.7	4.62	*1.0*	*2.0*	35.2	NA	NA	NA	NA	NA	NA	NA	NA
	WR5-PX-G-01	6/20/2008	85.3	6.97	*0.250*	*0.25*	*0.25*	*7.5*	*7.7*	1.87	0.78	21.2	41.1	26800	0.073	31.7	5.1	*1.0*	*2.0*	39.9	0.005	0.005	0.005	0.005	0.15	5.2	5.05	35
	WR6-PX-G-01	6/20/2008	92.5	6.19	*0.250*	*0.25*	1.26	NA	NA	35.2	*1.56*	13.1	108	28200	0.060	30.9	208	*1.0*	*2.0*	114	*0.005*	*0.005*	*0.005*	*0.005*	*0.15*	3.6	3.5	24
Mill Area	WR7-PX-G-01	6/20/2008	82.9	5.20	*0.250*	*0.25*	0.80	*7.5*	*7.7*	10.1	9.65	23.1	110	20300	1.120	26.9	28.1	*1.0*	*2.0*	76.5	0.02	0.01	0.005	0.03	0.5	8	7.5	16
	WR8-PX-G-01[a]	6/20/2008	71	6.57	*0.250*	*0.25*	*0.25*	NA	NA	6.5	0.88	13.8	32.3	18750	0.099	21.5	11.8	1.6	*2.0*	45.9	*NA*	*NA*	*NA*	*NA*	*NA*	NA	NA	NA
	WR9-PX-G-01	6/20/2008	83.5	6.01	*0.250*	*0.25*	0.70	NA	NA	14.4	5.88	21.9	50	17500	375	25.1	24.8	*1.0*	*2.0*	64.5	NA	NA	NA	NA	NA	NA	NA	NA
	WR10-PX-G-01	6/20/2008	72.9	6.21	*0.250*	*0.25*	*0.25*	NA	NA	3.9	*0.92*	24.2	29.4	18300	0.282	23	10.7	*1.0*	*2.0*	135	*0.005*	*0.005*	*0.005*	*0.005*	*0.15*	2.9	2.8	19
Conveyance Channel	TA1-PX-G-01	6/20/2008	74.3	6.4	*0.250*	*0.25*	0.52	NA	NA	14.3	0.77	15.8	26.2	16900	0.070	15.8	37.7	*1.0*	*2.0*	58.7	NA	NA	NA	NA	NA	NA	NA	NA
	TA5-PX-G-01	6/20/2008	78.6	6.06	*0.250*	*0.25*	0.89	NA	NA	27.5	1.11	20.3	34.8	19500	0.240	18.5	60.1	*1.0*	*2.0*	70.1	NA	NA	NA	NA	NA	NA	NA	NA
Tailings Impoundment	TA2-PX-G-01	6/20/2008	80.1	6.39	*0.250*	*0.25*	5.45	*7.5*	364	364	4.60	6.67	80.3	17200	0.135	12.4	1210	*1.0*	5.6	56.3	NA	NA	NA	NA	0.5	1.1	0.6	2.2
	TA3-PX-G-01	6/20/2008	81	6.28	*0.250*	*0.25*	4.22	NA	NA	269	2.27	8.56	60.7	14300	0.15	9.77	824	*1.0*	*2.0*	39.5	*0.005*	*0.005*	*0.005*	*0.005*	*0.15*	4	3.9	27
	TA4-PX-G-01	6/20/2008	82.9	6.76	*0.250*	*0.25*	1.97	NA	NA	121	2.37	24.5	52.7	21900	0.155	22.2	395	*1.0*	*2.0*	61.3	NA	NA	NA	NA	NA	NA	NA	NA
		minimum =	71.0	5.20	*0.250*	*0.25*	*0.25*	*7.50*	7.7	1.3	*0.77*	3.1	26.2	11800	*0.017*	4.8	3.10	1.0	*2.0*	27.8	NC	NC	NC	NC	NC	NC	NC	NC
		MDC =	**92.5**	**6.97**	***0.250***	***0.25***	**5.45**	***7.50***	**364**	**364**	**9.65**	**25**	**110**	**28500**	**375**	**33.7**	**1210**	**1.6**	***5.6***	**135**	NC	NC	NC	NC	NC	NC	NC	NC
		average =	80.8	6.17	0.250	0.25	1.17	7.50	126	66	2.45	15.8	58.9	20223	25.17	21.1	193.3	1.0	2.2	61.3	NC	NC	NC	NC	NC	NC	NC	NC
		90% UCL[b] =	NC	NC	*0.250*	*0.25*	0.71	*7.50*	698	396	26.1	77.1	91.6	61000	1.21	62.9	44.1	9.5	*5.6*	270	NC	NC	NC	NC	NC	NC	NC	NC
		# of samples = 18; Standard Deviation =	NC	NC	0.000	0.000	1.53	0.000	168	104	2.4	7.1	28.1	5193	93.5	8.5	345.6	0.1	0.9	28.3	NC	NC	NC	NC	NC	NC	NC	NC
		Frequency detected =	NC	NC	0%	0%	7%	0%	100%	100%	47%	100%	100%	100%	93%	100%	100%	100%	0%	100%	NC	NC	NC	NC	NC	NC	NC	NC
Human Health Screening Criteria																												
Oregon Industrial Maximum Allowable Soil Concentration Cleanup Levels (ODEQ 2000b)					NS	40000	10000	NS	NS	3	1000	1500	80000	NS	600	40000	2000	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
EPA Region IX Industrial Soil PRGs (EPA 2004b)					NS	1200	5100	NS	NS	1.6	450	450	41000	100000	310	20000	800	410	5100	100000	NS	NS	NS	NS	NS	NS	NS	NS
Ecological Screening Criteria																												
Oregon Level II Screening Values for Plants, Invertebrates, and Wildlife (Lowest value, ODEQ 2001)					NS	NS	2	10	NS	NS	4	NS	50	10	0.1	30	16	5	1	50	NS	NS	NS	NS	NS	NS	NS	NS
EPA Ecological Soil Screening Levels (Eco-SSLs) (EPA 2005)					NS	NS	NS	NS	NS	18	0.36	NS	NS	NS	NS	NS	11	0.27	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Notes:
Italics - result below laboratory reporting limit (RL), value = 1/2 RL.
Screening criteria exceeded.
[a]Average of sample WR8-PX-G-01 and duplicate sample WR8-PX-G-02.
[b]The MDC was used when the 90% UCL could not be calculated.
mg/kg = Milligram per kilogram
$TCaCO_3$/kT = Ton of calcium carbonate per kiloton of waste rock
AGP = Acid generating potential
ANP = Acid neutralizing potential
EPA = U.S. Environmental Protection Agency
MDC = Maximum detected concentration
NA = Not analyzed for
NC = Not calculated
NNP = Net neutralizing potential
NS = No screening criteria
ODEQ = Oregon Department of Environmental Quality
PRG = Preliminary remediation goal
TOT = Total
UCL = Upper confidence limit
WAD = Weak acid dissociable

TABLE 6
Toxicity Characterization Leaching Procedure and Synthetic Leaching Procedure Results Summary
Pyx Mine Site Inspection

Sample ID	Date Collected	Leachate Concentration (mg/L)													
		Arsenic		Cadmium		Chromium		Lead		Mercury		Selenium		Silver	
		TCLP	SPLP	TCLP	SPLP	TCLP	SPLP	TCLP	SPLP	TCLP	SPLP	TCLP	SPLP	TCLP	SPLP
WR5-PX-G-01	6/20/2008	*0.025*	*0.02*	0.005	*0.001*	*0.025*	*0.011*	*0.025*	*0.004*	*0.0001*	*0.0001*	*0.025*	*0.02*	*0.025*	*0.0025*
WR6-PX-G-01	6/20/2008	*0.025*	0.01	*0.005*	*0.001*	*0.025*	*0.003*	*0.025*	*0.012*	*0.0001*	0.0001	*0.025*	*0.02*	*0.025*	*0.0025*
WR7-PX-G-01	6/20/2008	0.03	0.01	0.132	*0.005*	*0.025*	*0.024*	*0.025*	*0.004*	*0.0001*	*0.0001*	*0.025*	*0.02*	*0.025*	*0.0025*
WR10-PX-G-01	6/20/2008	*0.025*	*0.01*	*0.005*	*0.001*	*0.025*	0.036	*0.025*	*0.004*	*0.0001*	*0.0001*	*0.025*	*0.02*	*0.025*	*0.0025*
TA2-PX-G-01	6/20/2008	*0.025*	0.2	0.052	0.002	*0.025*	0.008	0.283	0.343	*0.0001*	*0.0001*	*0.025*	*0.02*	*0.025*	0.005
TA3-PX-G-01	6/20/2008	*0.025*	0.07	*0.005*	*0.001*	*0.025*	0.011	*0.025*	0.106	*0.0001*	*0.0001*	*0.025*	*0.02*	*0.025*	*0.0025*
RCRA TCLP Disposal Limit =		**5**		**1**		**5**		**5**		**0.2**		**1**		**5**	

Notes:
Italics - result below laboratory reporting limit (RL), value = 1/2 RL.
mg/L = Milligram per liter
RCRA = Resource Conservation and Recovery Act
SPLP = Synthetic Precipitation Leaching Procedure
TCLP = Toxicity Characteristic Leaching Procedure

TABLE 7
Sediment Analytical Results Summary
Pyx Mine Site Inspection

Sample ID	Date Collected	Solids (%)	Total Organic Matter (%)	Total Organic Carbon (%)	Analyte Concentration (mg/kg)															
					CN (WAD)	CN (TOT)	Ag	As_3	As_5	As_T	Cd	Cr_T	Cu	Fe	Hg	Ni	Pb	Sb	Se	Zn
SD1-PX-G-01	6/20/2008	56.2	0.7	0.04	*1.25*	*0.25*	*0.25*	*7.5*	*7.7*	5.4	*0.10*	20.4	34.2	23000	0.070	23.1	2.91	*1.0*	*2.0*	33.7
Human Health Screening Criteria																				
Oregon Industrial Maximum Allowable Soil Concentration Cleanup Levels – Human Receptors (ODEQ 2000b)					40000	40000	10000	NS	NS	3	1000	1500	80000	NS	600	40000	2000	NS	NS	NS
EPA Region IX Industrial Soil PRGs (EPA 2004a)					1200	1200	5100	NS	NS	1.6	450	450	41000	100000	310	20000	800	410	5100	100000
Ecological Screening Criteria																				
Oregon Guidance for Ecological Risk Assessment Level II Screening Level Values (Fresh water or bioaccumulation, whichever is lower, ODEQ 2001)					NS	NS	4.5	4	NS	NS	0.003	37	10	NS	0.2	18	35	3	0.1	3
EPA Threshold Effects Level (NOAA 1999)					NS	NS	NS	NS	NS	5.9	0.596	37.3	35.7	NS	0.174	18	35	NS	NS	123
EPA Freshwater Probable Effects Level (NOAA 1999)					NS	NS	NS	NS	NS	17	3.53	90	197	NS	0.486	35.9	91.3	NS	NS	315

Notes:
Italics - result below laboratory reporting limit (RL), value = 1/2 RL.
Screening criteria exceeded.
mg/kg = Milligram per kilogram
CN = Cyanide
EPA = U.S. Environmental Protection Agency
MDC = Maximum detected concentration
NOAA = National Oceanic and Atmospheric Administration
NS = No screening criteria
ODEQ = Oregon Department of Environmental Quality
PRG = Preliminary remediation goal
TOT = Total
WAD = Weak acid dissociable

TABLE 8
Surface Water Analytical Results Summary
Pyx Mine Site Inspection

Sample ID	Date Collected	pH	Hard	Analyte Concentration (mg/L)[a]																	
				TDS	Ca_T	Mg_T	Sulfate	CN (WAD)	CN (TOT)	Ag_D	As_3	As_5	As_D	Cd_D	Cr_D	Cu_D	Fe_D	Hg_D	Ni_D	Pb_D	Sb_D	Se_D	Zn_D
SW1-PX-G-01	6/20/2008	7.19	51.9	95	15.8	3.06	1.29	*0.0050*	*0.0050*	*0.000063*	NA	NA	*0.00150*	*0.00010*	*0.00125*	0.00125	0.074	*0.00010*	*0.00050*	*0.00150*	*0.00150*	*0.00150*	*0.0050*
Human Health Screening Criteria																							
1 - Oregon HH		NS	NS	NS	NS	NS	NS	NS	0.14	0.050	NS	NS	0.0000022	NS	NS	NS	0.3	0.0001	0.61	NS	0.006	0.17	7.4
2 - EPA HH		5-9	NS	NS	NS	NS	NS	NS	0.14	NS	NS	NS	0.000018	NS	NS	1.3	0.3	NS	0.61	NS	0.006	0.17	7.4
Ecological Screening Criteria																							
3 - Oregon Eco[b]		NS	NS	NS	NS	NS	NS	NS	0.0052	0.0001	190	NS	NS	0.0002	NS	0.01	1	0.000012	0.030	1.38	NS	0.005	0.069
4 - EPA Eco[b]		NS	NS	NS	NS	NS	NS	NS	0.0052	0.00036	NS	0.0031	0.15	0.0002	NS	0.01	1	0.00077	0.030	1.38	0.03	0.005	0.069

Sample ID	Field Parameters				
	Flow (gpm)	Temp. °C	EC (µS/cm)	DO (mg/L)	ORP (mV)
SW1-PX-G-01	<1 gpm	5.5	83	6.81	72.6

Notes:
Italics - result below laboratory reporting limit (RL), value = 1/2 RL.
Screening criteria exceeded.
[a]D denotes dissolved concentration; T denotes total concentration
[b]Screening criteria for hardness dependent metals are based on the sample hardness of 51.9.
1-State of Oregon human health water quality criteria, water and fish consumption, Tables 20, 33A, 33B (ODEQ 2005)
2-EPA recommended chronic ambient water quality criteria for human consumption of water and fish (EPA 2006)
3-State of Oregon ambient water quality criteria for protection of aquatic life, chronic criterion Tables 20, 33A, 33B (ODEQ 2005)
4-EPA recommended chronic ambient water quality criteria for freshwater aquatic life (EPA 2006); if none existed then used Tier II secondary chronic values (NOAA 1999)
°C = Celsius
gpm = Gallon per minute
mg/L = Milligram per liter
µS/cm = Microsiemen per centimeter
mV = Millivolt
CN = Cyanide
DO = Dissolved oxygen
EC = Electrical conductivity
EPA = U.S. Environmental Protection Agency
Hard = Hardness as calcium carbonate ($CaCO_3$)
MDC = Maximum detected concentration
NA = Not analyzed for
NOAA = National Oceanic and Atmospheric Administration
NS = No screening criteria
ODEQ = Oregon Department of Environmental Quality
ORP = Oxygen reduction potential
TDS = Total dissolved solids
Temp = Temperature
TOT = Total
WAD = Weak acid dissociable

TABLE 9
Human Health Hazard and Cancer Risk Summary
Pyx Mine Site Inspection

Receptor	Media			TOTAL	Risk Screening Level[a]
	Mine Waste	Sediment	Surface Water		
	RME Hazard Quotient				
Child Recreationalist	0.3	0.003	0.0001	0.3	1
Adult Recreationalist	0.1	0.0004	0.0001	0.1	1
Adult Worker	0.6	0.003	0.0003	0.6	1
	CTE Hazard Quotient				
Child Recreationalist	0.01	0.0002	0.00003	0.01	1
Adult Recreationalist	0.004	0.0001	0.00003	0.004	1
Adult Worker	0.01	0.0002	0.0001	0.01	1
	RME Cancer Risk				
Child Recreationalist	**1E-05**	1E-07	2E-09	**1E-05**	1E-06
Adult Recreationalist	**8E-06**	8E-08	1E-08	**8E-06**	1E-06
Adult Worker	**8E-05**	5E-07	3E-08	**8E-05**	1E-06
	CTE Cancer Risk				
Child Recreationalist	3E-07	7E-09	8E-10	3E-07	1E-06
Adult Recreationalist	2E-07	5E-09	1E-09	2E-07	1E-06
Adult Worker	4E-07	7E-09	2E-09	4E-07	1E-06

Notes:

[a]Oregon acceptable risk levels (ODEQ 2000a)

Bold values exceed risk screening levels.

CTE = Central tendency exposure

RME = Reasonable maximum exposure

TABLE 10
Summary of Hot Spots and Areas Exceeding Risk-based Cleanup Levels
Pyx Mine Site Inspection

Media	Area	Contaminant	Risk-based Hot Spot Concentration (mg/kg)	Risk-based Cleanup Level (mg/kg)	Maximum Detected Concentration (mg/kg)	Estimated Volume (bcy)
Waste rock	Waste rock pile WR1	Arsenic	460	46	62.9	3,200
Tailings	Tailings impoundment				364	540
Total Estimated Volume of Waste Material Exceeding Arsenic Cleanup Level (bcy) =						**3,740**

Notes:

bcy = Bank cubic yard

mg/kg = Milligram per kilogram

TABLE 11
Ecological Risk Ratio Summary
Pyx Mine Site Inspection

	Mine Waste				Surface Water			Sediment	
CPEC	**Plant**	**Invertebrate**	**Bird**	**Mammal**	**Bird**	**Mammal**	**Aquatic Life**	**Freshwater**	**Bio-accumulation**
Antimony	<5	NS	NS	<5	--	--	--	**--**	**--**
Arsenic V	NS	NS	NS	NS	--	--	--	--	--
Arsenic Total	NS	NS	NS	NS	--	--	--	NS	NS
Chromium Total	NS	NS	NS	NS	--	--	--	<5	<5
Iron	**2,850**	**143**	NS	NS	--	--	--	--	--
Lead	**24**	<5	**65**	<5	--	--	--	<5	<5
Mercury	**1,250**	**3,750**	**100**	<5	--	--	--	<5	NS
Selenium	**6**	<5	<5	<5	--	--	--	--	--
Silver	<5	<5	NS	NS	--	--	--	--	--
Zinc	<5	<5	<5	<5	--	--	--	<5	**11**

Notes:
Bold values exceed the risk screening ratio for non-protected species, i.e. Q > 5.
CPEC = Contaminant of potential ecological concern
NS = No screening level value
-- Not calculated because not a CPEC for this media.

APPENDIX A

SENSITIVE PLANT AND ANIMAL SPECIES

FEDERALLY LISTED THREATENED, ENDANGERED, PROPOSED, CANDIDATE SPECIES AND SPECIES OF CONCERN WHICH MAY OCCUR WITHIN GRANT COUNTY, OREGON

LISTED SPECIES[1/]

Mammals		
Canada lynx[2/]	*Felis lynx canadensis*	T
Birds		
Bald eagle[3/]	*Haliaeetus leucocephalus*	T
Fish		
Steelhead (Middle Columbia River)[4/]	*Oncorhynchus mykiss* ssp.	T*
Bull trout (Columbia River Basin)[5/]	*Salvelinus confluentus*	CH T

PROPOSED SPECIES

None

CANDIDATE SPECIES[6/]

Mammals	
Pacific fisher[7/]	*Martes pennanti pacifica*
Birds	
Yellow-billed cuckoo	*Coccyzus americanus*
Amphibians and Reptiles	
Columbia spotted frog	*Rana luteiventris*

SPECIES OF CONCERN

Mammals	
Pygmy rabbit	*Brachylagus idahoensis*
Pale western big-eared bat	*Corynorhinus townsendii pallescens*
California wolverine	*Gulo gulo luteus*
Silver-haired bat	*Lasionycteris noctivagans*
Small-footed myotis (bat)	*Myotis ciliolabrum*
Long-eared myotis (bat)	*Myotis evotis*
Fringed myotis (bat)	*Myotis thysanodes*
Long-legged myotis (bat)	*Myotis volans*
Yuma myotis (bat)	*Myotis yumanensis*
California bighorn	*Ovis canadensis californiana*
Preble's shrew	*Sorex preblei*
Birds	
Northern goshawk	*Accipiter gentilis*
Western burrowing owl	*Athene cunicularia hypugea*
Upland sandpiper	*Bartramia longicauda*
Ferruginous hawk	*Buteo regalis*
Black tern	*Chlidonias niger*
Olive-sided flycatcher	*Contopus cooperi*
Willow flycatcher	*Empidonax trailli adastus*
Yellow-breasted chat	*Icteria virens*
Lewis' woodpecker	*Melanerpes lewis*
Mountain quail	*Oreortyx pictus*

White-headed woodpecker	*Picoides albolarvatus*
Amphibians and Reptiles	
Northern sagebrush lizard	*Sceloporus graciosus graciosus*
Fishes	
Malheur mottled sculpin	*Cottus bairdi* ssp.
Pacific lamprey	*Lampetra tridentata*
Westslope cutthroat trout	*Oncorhynchus clarki lewisi*
Interior redband trout	*Oncorhynchus mykiss gibbsi*
Invertebrates	
California floater (mussel)	*Anodonta californiensis*
Plants	
Wallowa ricegrass	*Achnatherum wallowaensis*
Upward-lobed moonwort	*Botrychium ascendens*
Crenulate grape-fern	*Botrychium crenulatum*
Mountain grape-fern	*Botrychium montanum*
Twin spike moonwort	*Botrychium paradoxum*
Stalked moonwort	*Botrychium pedunculosum*
Peck's mariposa-lily	*Calochortus longebarbatus* var. *peckii*
Dwarf evening-primrose	*Camissonia pygmaea*
Idaho sedge	*Carex idahoa*
Colonial luina	*Luina serpentina*
Disappearing monkeyflower	*Mimulus evanescens*
Little mousetail	*Myosurus minimus* ssp. *apus* (= var. *sessiliflorus*)
Tiny-flower phacelia	*Phacelia minutissima*
Oregon semaphore grass	*Pleuropogon oregonus*
Arrow-leaf thelypody	*Thelypodium eucosmum*
Howell's theylpody	*Thelypodium howellii* ssp. *howellii*

(E) - Listed Endangered *(T) - Listed Threatened* *(CH) - Critical Habitat has been designated for this species*
(PE) - Proposed Endangered *(PT) - Proposed Threatened* *(PCH) - Critical Habitat has been proposed for this species*

Species of Concern - Taxa whose conservation status is of concern to the Service (many previously known as Category 2 candidates), but for which further information is still needed.

* *Consultation with NOAA's National Marine Fisheries Service may be required.*

[1/] *U.S. Department of Interior, Fish and Wildlife Service, October 31, 2000, Endangered and Threatened Wildlife and Plants, 50 CFR 17.11 and 17.12*
[2/] *Federal Register Vol. 65, No. 58, Mar 24, 2000, Final Rule - Canada lynx*
[3/] *Federal Register Vol. 60, No. 133, July 12, 1995, - Final Rule - Bald Eagle*
[4/] *Federal Register Vol. 64, No. 57, March 25, 1999, Final Rule - Middle Columbia and Upper Willamette River Steelhead*
[5/] *Federal Register Vol. 63, No. 111, June 10, 1998, Final Rule - Columbia River and Klamath River Bull Trout*
[6/] *Federal Register Vol. 69, No. 86, May 4, 2004, Notice of Review - Candidate or Proposed Animals and Plants*
[7/] *Federal Register Vol. 69, No. 68, April 8, 2004, 12-Month Finding for a Petition to List the West Coast Distinct Population Segment of the Fisher*

LIST OF SPECIES THAT COULD POTENTIALLY INHABIT THE PYX MINE SITE

ELCODE	COMMON NAME	SPECIES NAME	FAMILY	TAXONOMIC CLASS
AMAJF04010	Ameican badger	Taxidea taxus	Mustelidae	Mammalia
AMAFE01010	American beaver	Castor canadensis	Castoridae	Mammalia
AMAJF01010	American marten	Martes americana	Mustelidae	Mammalia
AMAEA01020	American pika	Ochotona princeps	Ochotonidae	Mammalia
AMAFB05060	Belding's ground squirrel	Spermophilus beldingi	Sciuridae	Mammalia
AMACC04010	Big brown bat	Eptesicus fuscus	Vespertilionidae	Mammalia
AMALE04010	Bighorn sheep	Ovis canadensis	Bovidae	Mammalia
AMAJB01010	Black bear	Ursus americanus	Ursidae	Mammalia
AMALC02010	Black-tailed deer	Odocoileus hemionus	Cervidae	Mammalia
AMAEB03050	Black-tailed jack rabbit	Lepus californicus	Leporidae	Mammalia
AMAJH03020	Bobcat	Lynx rufus	Felidae	Mammalia
AMAFF08090	Bushy-tailed woodrat	Neotoma cinerea	Cricetidae	Mammalia
AMACC01120	California myotis	Myotis californicus	Vespertilionidae	Mammalia
AMAJH03010	Canada lynx	Lynx canadensis	Felidae	Mammalia
AMAFF03090	Canyon mouse	Peromyscus crinitus	Cricetidae	Mammalia
AMABB02020	Coast mole	Scapanus orarius	Talpidae	Mammalia
AMAFB05070	Columbian ground squirrel	Spermophilus columbianus	Sciuridae	Mammalia
AMAFJ01010	Common porcupine	Erethizon dorsatum	Erethizontidae	Mammalia
AMAJE02010	Common raccoon	Procyon lotor	Procyonidae	Mammalia
AMAJA01010	Coyote	Canis latrans	Canidae	Mammalia
AMAFF03040	Deer mouse	Peromyscus maniculatus	Cricetidae	Mammalia
AMAFB08020	Douglas' squirrel	Tamiasciurus douglasii	Sciuridae	Mammalia
AMABA01080	Dusky shrew	Sorex monticolus	Soricidae	Mammalia
AMALC01010	Elk	Cervus canadensis	Cervidae	Mammalia
AMAJF02010	Ermine	Mustela erminea	Mustelidae	Mammalia
AMAJF01020	Fisher	Martes pennanti	Mustelidae	Mammalia
AMACC01090	Fringed myotis	Myotis thysanodes	Vespertilionidae	Mammalia
AMAFB05170	Golden-mantled ground squirrel	Spermophilus lateralis	Sciuridae	Mammalia
AMAFD01070	Great Basin pocket mouse	Perognathus parvus	Heteromyidae	Mammalia
AMAFF10010	Heather vole	Phenacomys intermedius	Cricetidae	Mammalia
AMACC05030	Hoary bat	Lasiurus cinereus	Vespertilionidae	Mammalia
AMAFF22010	House mouse	Mus musculus	Muridae	Mammalia
AMAFB02020	Least chipmunk	Neotamias minimus	Sciuridae	Mammalia
AMACC01010	Little brown myotis	Myotis lucifugus	Vespertilionidae	Mammalia
AMACC01070	Long-eared myotis	Myotis evotis	Vespertilionidae	Mammalia
AMACC01110	Long-legged myotis	Myotis volans	Vespertilionidae	Mammalia
AMAFF11060	Long-tailed vole	Microtus longicaudus	Cricetidae	Mammalia
AMAJF02030	Long-tailed weasel	Mustela frenata	Mustelidae	Mammalia
AMAFB05210	Merriam's ground squirrel	Spermophilus canus	Sciuridae	Mammalia
AMAJF02050	Mink	Neovison vison	Mustelidae	Mammalia
AMAFF11020	Montane vole	Microtus montanus	Cricetidae	Mammalia
AMALE02010	Mountain goat	Oreamnos americanus	Bovidae	Mammalia
AMAJH04010	Mountain lion	Puma concolor	Felidae	Mammalia
AMAFF15010	Muskrat	Ondatra zibethicus	Cricetidae	Mammalia
AMAFB09020	Northern flying squirrel	Glaucomys sabrinus	Sciuridae	Mammalia
AMAFF06010	Northern grasshopper mouse	Onychomys leucogaster	Cricetidae	Mammalia

ELCODE	COMMON NAME	SPECIES NAME	FAMILY	TAXONOMIC CLASS
AMAFC01040	Northern pocket gopher	Thomomys talpoides	Geomyidae	Mammalia
AMAFF21020	Norway rat	Rattus norvegicus	Muridae	Mammalia
AMAEB01060	Nuttall's cottontail	Sylvilagus nuttallii	Leporidae	Mammalia
AMAFD03010	Ord's kangaroo rat	Dipodomys ordii	Heteromyidae	Mammalia
AMACC10010	Pallid bat	Antrozous pallidus	Vespertilionidae	Mammalia
AMAFF03130	Pinon mouse	Peromyscus truei	Cricetidae	Mammalia
AMALD01010	Pronghorn	Antilocapra americana	Antilocapridae	Mammalia
AMAEB04010	Pygmy rabbit	Brachylagus idahoensis	Leporidae	Mammalia
AMAJA03010	Red fox	Vulpes vulpes	Canidae	Mammalia
AMAFB08010	Red squirrel	Tamiasciurus hudsonicus	Sciuridae	Mammalia
AMAFF13010	Sagebrush vole	Lemmiscus curtatus	Cricetidae	Mammalia
AMACC02010	Silver-haired bat	Lasionycteris noctivagans	Vespertilionidae	Mammalia
AMAEB03010	Snowshoe hare	Lepus americanus	Leporidae	Mammalia
AMAFF09020	Southern red-backed vole	Myodes gapperi	Cricetidae	Mammalia
AMACC07010	Spotted bat	Euderma maculatum	Vespertilionidae	Mammalia
AMAJF06010	Striped skunk	Mephitis mephitis	Mephitidae	Mammalia
AMABA01070	Vagrant shrew	Sorex vagrans	Soricidae	Mammalia
AMABA01150	Water shrew	Sorex palustris	Soricidae	Mammalia
AMAFF11190	Water vole	Microtus richardsoni	Cricetidae	Mammalia
AMAFF02030	Western harvest mouse	Reithrodontomys megalotis	Cricetidae	Mammalia
AMAFH01020	Western jumping mouse	Zapus princeps	Dipodidae	Mammalia
AMACC03010	Western pipistrelle	Pipistrellus hesperus	Vespertilionidae	Mammalia
AMACC01140	Western small-footed myotis	Myotis ciliolabrum	Vespertilionidae	Mammalia
AMAJF05020	Western spotted skunk	Spilogale gracilis	Mephitidae	Mammalia
AMAEB03040	White-tailed jackrabbit	Lepus townsendii	Leporidae	Mammalia
AMAJF03010	Wolverine	Gulo gulo	Mustelidae	Mammalia
AMAFB03020	Yellow-bellied marmot	Marmota flaviventris	Sciuridae	Mammalia
AMAFB02030	Yellow-pine chipmunk	Neotamias amoenus	Sciuridae	Mammalia
AMACC01020	Yuma myotis	Myotis yumanensis	Vespertilionidae	Mammalia
ARADB36130	Common garter snake	Thamnophis sirtalis	Colubridae	Reptilia
ARADB26020	Gopher snake	Pituophis catenifer	Colubridae	Reptilia
ARADB18010	Night snake	Hypsiglena torquata	Colubridae	Reptilia
ARAAD01010	Painted turtle	Chrysemys picta	Emydidae	Reptilia
ARADB07010	Racer	Coluber constrictor	Colubridae	Reptilia
ARADB10010	Ringneck snake	Diadophis punctatus	Colubridae	Reptilia
ARADA01010	Rubber boa	Charina bottae	Boidae	Reptilia
ARACF14030	Sagebrush lizard	Sceloporus graciosus	Phrynosomatidae	Reptilia
ARACF12030	Short-horned lizard	Phrynosoma douglasii	Phrynosomatidae	Reptilia
ARACF17010	Side-blotched lizard	Uta stansburiana	Phrynosomatidae	Reptilia
ARACB01040	Southern alligator lizard	Elgaria multicarinata	Anguidae	Reptilia
ARADB21040	Striped whipsnake	Masticophis taeniatus	Colubridae	Reptilia
ARACF14080	Western fence lizard	Sceloporus occidentalis	Phrynosomatidae	Reptilia
ARADE02140	Western rattlesnake	Crotalus oreganus	Viperidae	Reptilia
ARACH01110	Western skink	Eumeces skiltonianus	Scincidae	Reptilia
ARADB36050	Western terrestrial garter snake	Thamnophis elegans	Colubridae	Reptilia
ARACJ02140	Western whiptail	Aspidoscelis tigris	Teiidae	Reptilia
AAABH01070	Bullfrog	Rana catesbeiana	Ranidae	Amphibia
AAABH01290	Columbia spotted frog	Rana luteiventris	Ranidae	Amphibia
AAABF02030	Great Basin spadefoot	Spea intermontana	Scaphiopodidae	Amphibia

ELCODE	COMMON NAME	SPECIES NAME	FAMILY	TAXONOMIC CLASS
AAAAA01080	Long-toed salamander	Ambystoma macrodactylum	Ambystomatidae	Amphibia
AAABC05100	Pacific chorus frog	Pseudacris regilla	Hylidae	Amphibia
AAABB01030	Western toad	Bufo boreas	Bufonidae	Amphibia
ABNGA01020	American bittern	Botaurus lentiginosus	Ardeidae	Aves
ABNME14020	American coot	Fulica americana	Rallidae	Aves
ABPAV10010	American crow	Corvus brachyrhynchos	Corvidae	Aves
ABPBH01010	American dipper	Cinclus mexicanus	Cinclidae	Aves
ABPBY06110	American goldfinch	Carduelis tristis	Fringillidae	Aves
ABNKD06020	American kestrel	Falco sparverius	Falconidae	Aves
ABPBX06010	American redstart	Setophaga ruticilla	Parulidae	Aves
ABPBJ20170	American robin	Turdus migratorius	Turdidae	Aves
ABNYF07110	American three-toed woodpecker	Picoides dorsalis	Picidae	Aves
ABNJB10180	American wigeon	Anas americana	Anatidae	Aves
ABPAE43050	Ash-throated flycatcher	Myiarchus cinerascens	Tyrannidae	Aves
ABNKC10010	Bald eagle	Haliaeetus leucocephalus	Accipitridae	Aves
ABPAU08010	Bank swallow	Riparia riparia	Hirundinidae	Aves
ABNSA01010	Barn owl	Tyto alba	Tytonidae	Aves
ABPAU09030	Barn swallow	Hirundo rustica	Hirundinidae	Aves
ABNSB12020	Barred owl	Strix varia	Strigidae	Aves
ABNXD01020	Belted kingfisher	Ceryle alcyon	Alcedinidae	Aves
ABNNM10020	Black tern	Chlidonias niger	Laridae	Aves
ABNYF07090	Black-backed woodpecker	Picoides arcticus	Picidae	Aves
ABPAV09010	Black-billed magpie	Pica hudsonia	Corvidae	Aves
ABPAW01010	Black-capped chickadee	Poecile atricapillus	Paridae	Aves
ABNUC45020	Black-chinned hummingbird	Archilochus alexandri	Trochilidae	Aves
ABNGA11010	Black-crowned night-heron	Nycticorax nycticorax	Ardeidae	Aves
ABPBX61040	Black-headed grosbeak	Pheucticus melanocephalus	Cardinalidae	Aves
ABPBX03070	Black-throated gray warbler	Dendroica nigrescens	Parulidae	Aves
ABNLC09020	Blue grouse	Dendragapus obscurus	Phasianidae	Aves
ABNJB10130	Blue-winged teal	Anas discors	Anatidae	Aves
ABPBXA9010	Bobolink	Dolichonyx oryzivorus	Icteridae	Aves
ABNSB15010	Boreal owl	Aegolius funereus	Strigidae	Aves
ABPBXB5020	Brewer's blackbird	Euphagus cyanocephalus	Icteridae	Aves
ABPBX94040	Brewer's sparrow	Spizella breweri	Emberizidae	Aves
ABPBA01010	Brown creeper	Certhia americana	Certhiidae	Aves
ABPBXB7030	Brown-headed cowbird	Molothrus ater	Icteridae	Aves
ABNSB10010	Burrowing owl	Athene cunicularia	Strigidae	Aves
ABPAY01010	Bushtit	Psaltriparus minimus	Aegithalidae	Aves
ABNLC23040	California quail	Callipepla californica	Odontophoridae	Aves
ABNUC48010	Calliope hummingbird	Stellula calliope	Trochilidae	Aves
ABNJB05030	Canada goose	Branta canadensis	Anatidae	Aves
ABNJB11020	Canvasback	Aythya valisineria	Anatidae	Aves
ABPBG04010	Canyon wren	Catherpes mexicanus	Troglodytidae	Aves
ABPBY04030	Cassin's finch	Carpodacus cassinii	Fringillidae	Aves
ABPBW01290	Cassin's vireo	Vireo cassinii	Vireonidae	Aves
ABPBN01020	Cedar waxwing	Bombycilla cedrorum	Bombycillidae	Aves
ABPAW01070	Chestnut-backed chickadee	Poecile rufescens	Paridae	Aves
ABPBX94020	Chipping sparrow	Spizella passerina	Emberizidae	Aves

ELCODE	COMMON NAME	SPECIES NAME	FAMILY	TAXONOMIC CLASS
ABNLC03010	Chukar	Alectoris chukar	Phasianidae	Aves
ABNJB10140	Cinnamon teal	Anas cyanoptera	Anatidae	Aves
ABPAV08010	Clark's nutcracker	Nucifraga columbiana	Corvidae	Aves
ABPAU09010	Cliff swallow	Petrochelidon pyrrhonota	Hirundinidae	Aves
ABNJB21010	Common merganser	Mergus merganser	Anatidae	Aves
ABNTA02020	Common nighthawk	Chordeiles minor	Caprimulgidae	Aves
ABNTA04010	Common poorwill	Phalaenoptilus nuttallii	Caprimulgidae	Aves
ABPAV10110	Common raven	Corvus corax	Corvidae	Aves
ABPBX12010	Common yellowthroat	Geothlypis trichas	Parulidae	Aves
ABNKC12040	Cooper's hawk	Accipiter cooperii	Accipitridae	Aves
ABPBXA5020	Dark-eyed junco	Junco hyemalis	Emberizidae	Aves
ABNYF07030	Downy woodpecker	Picoides pubescens	Picidae	Aves
ABPAE33090	Dusky flycatcher	Empidonax oberholseri	Tyrannidae	Aves
ABPAE52060	Eastern kingbird	Tyrannus tyrannus	Tyrannidae	Aves
ABPBT01010	European starling	Sturnus vulgaris	Sturnidae	Aves
ABPBY09020	Evening grosbeak	Coccothraustes vespertinus	Fringillidae	Aves
ABNKC19120	Ferruginous hawk	Buteo regalis	Accipitridae	Aves
ABNSB01020	Flammulated owl	Otus flammeolus	Strigidae	Aves
ABPBXA2010	Fox sparrow	Passerella iliaca	Emberizidae	Aves
ABNJB10160	Gadwall	Anas strepera	Anatidae	Aves
ABNKC22010	Golden eagle	Aquila chrysaetos	Accipitridae	Aves
ABPBJ05010	Golden-crowned kinglet	Regulus satrapa	Regulidae	Aves
ABPBXA0020	Grasshopper sparrow	Ammodramus savannarum	Emberizidae	Aves
ABPBK01010	Gray catbird	Dumetella carolinensis	Mimidae	Aves
ABPAE33100	Gray flycatcher	Empidonax wrightii	Tyrannidae	Aves
ABPAV01010	Gray jay	Perisoreus canadensis	Corvidae	Aves
ABNLC01010	Gray partridge	Perdix perdix	Phasianidae	Aves
ABNGA04010	Great blue heron	Ardea herodias	Ardeidae	Aves
ABNSB12040	Great gray owl	Strix nebulosa	Strigidae	Aves
ABNSB05010	Great horned owl	Bubo virginianus	Strigidae	Aves
ABNLC12010	Greater sage-grouse	Centrocercus urophasianus	Phasianidae	Aves
ABPBX74010	Green-tailed towhee	Pipilo chlorurus	Emberizidae	Aves
ABNYF07040	Hairy woodpecker	Picoides villosus	Picidae	Aves
ABPAE33080	Hammond's flycatcher	Empidonax hammondii	Tyrannidae	Aves
ABPBJ18110	Hermit thrush	Catharus guttatus	Turdidae	Aves
ABNJB20010	Hooded merganser	Lophodytes cucullatus	Anatidae	Aves
ABPAT02010	Horned lark	Eremophila alpestris	Alaudidae	Aves
ABPBY04040	House finch	Carpodacus mexicanus	Fringillidae	Aves
ABPBZ01010	House sparrow	Passer domesticus	Passeridae	Aves
ABPBG09010	House wren	Troglodytes aedon	Troglodytidae	Aves
ABNNB03090	Killdeer	Charadrius vociferus	Charadriidae	Aves
ABPBX96010	Lark sparrow	Chondestes grammacus	Emberizidae	Aves
ABPBX64020	Lazuli bunting	Passerina amoena	Cardinalidae	Aves
ABPAE33070	Least flycatcher	Empidonax minimus	Tyrannidae	Aves
ABPBY06090	Lesser goldfinch	Carduelis psaltria	Fringillidae	Aves
ABNJB11070	Lesser scaup	Aythya affinis	Anatidae	Aves
ABNYF04010	Lewis's woodpecker	Melanerpes lewis	Picidae	Aves
ABPBXA3020	Lincoln's sparrow	Melospiza lincolnii	Emberizidae	Aves

ELCODE	COMMON NAME	SPECIES NAME	FAMILY	TAXONOMIC CLASS
ABPBR01030	Loggerhead shrike	Lanius ludovicianus	Laniidae	Aves
ABNNF07070	Long-billed curlew	Numenius americanus	Scolopacidae	Aves
ABNSB13010	Long-eared owl	Asio otus	Strigidae	Aves
ABPBX11040	Macgillivray's warbler	Oporornis tolmiei	Parulidae	Aves
ABNJB10060	Mallard	Anas platyrhynchos	Anatidae	Aves
ABPBG10020	Marsh wren	Cistothorus palustris	Troglodytidae	Aves
ABPBJ15030	Mountain bluebird	Sialia currucoides	Turdidae	Aves
ABPAW01040	Mountain chickadee	Poecile gambeli	Paridae	Aves
ABNLC24010	Mountain quail	Oreortyx pictus	Odontophoridae	Aves
ABNPB04040	Mourning dove	Zenaida macroura	Columbidae	Aves
ABPBX01060	Nashville warbler	Vermivora ruficapilla	Parulidae	Aves
ABNYF10020	Northern flicker	Colaptes auratus	Picidae	Aves
ABNKC12060	Northern goshawk	Accipiter gentilis	Accipitridae	Aves
ABNKC11010	Northern harrier	Circus cyaneus	Accipitridae	Aves
ABNJB10110	Northern pintail	Anas acuta	Anatidae	Aves
ABNSB08010	Northern pygmy-owl	Glaucidium gnoma	Strigidae	Aves
ABPAU07010	Northern rough-winged swallow	Stelgidopteryx serripennis	Hirundinidae	Aves
ABNSB15020	Northern saw-whet owl	Aegolius acadicus	Strigidae	Aves
ABNJB10150	Northern shoveler	Anas clypeata	Anatidae	Aves
ABPAE32010	Olive-sided flycatcher	Contopus cooperi	Tyrannidae	Aves
ABPBX01050	Orange-crowned warbler	Vermivora celata	Parulidae	Aves
ABNKC01010	Osprey	Pandion haliaetus	Accipitridae	Aves
ABNKD06070	Peregrine falcon	Falco peregrinus	Falconidae	Aves
ABNCA02010	Pied-billed grebe	Podilymbus podiceps	Podicipedidae	Aves
ABNYF12020	Pileated woodpecker	Dryocopus pileatus	Picidae	Aves
ABPBY03010	Pine grosbeak	Pinicola enucleator	Fringillidae	Aves
ABPBY06030	Pine siskin	Carduelis pinus	Fringillidae	Aves
ABNKD06090	Prairie falcon	Falco mexicanus	Falconidae	Aves
ABPAZ01030	Pygmy nuthatch	Sitta pygmaea	Sittidae	Aves
ABPBY05010	Red crossbill	Loxia curvirostra	Fringillidae	Aves
ABPAZ01010	Red-breasted nuthatch	Sitta canadensis	Sittidae	Aves
ABPBW01240	Red-eyed vireo	Vireo olivaceus	Vireonidae	Aves
ABNJB11030	Redhead	Aythya americana	Anatidae	Aves
ABNYF05040	Red-naped sapsucker	Sphyrapicus nuchalis	Picidae	Aves
ABNKC19110	Red-tailed hawk	Buteo jamaicensis	Accipitridae	Aves
ABPBXB0010	Red-winged blackbird	Agelaius phoeniceus	Icteridae	Aves
ABNJB11040	Ring-necked duck	Aythya collaris	Anatidae	Aves
ABNLC07010	Ring-necked pheasant	Phasianus colchicus	Phasianidae	Aves
ABNPB01010	Rock pigeon	Columba livia	Columbidae	Aves
ABPBG03010	Rock wren	Salpinctes obsoletus	Troglodytidae	Aves
ABPBJ05020	Ruby-crowned kinglet	Regulus calendula	Regulidae	Aves
ABNJB22010	Ruddy duck	Oxyura jamaicensis	Anatidae	Aves
ABNLC11010	Ruffed grouse	Bonasa umbellus	Phasianidae	Aves
ABNUC51020	Rufous hummingbird	Selasphorus rufus	Trochilidae	Aves
ABPBK04010	Sage thrasher	Oreoscoptes montanus	Mimidae	Aves
ABNMK01010	Sandhill crane	Grus canadensis	Gruidae	Aves
ABPBX99010	Savannah sparrow	Passerculus sandwichensis	Emberizidae	Aves
ABPAE35030	Say's phoebe	Sayornis saya	Tyrannidae	Aves
ABNKC12020	Sharp-shinned hawk	Accipiter striatus	Accipitridae	Aves

ELCODE	COMMON NAME	SPECIES NAME	FAMILY	TAXONOMIC CLASS
ABNSB13040	Short-eared owl	Asio flammeus	Strigidae	Aves
ABPBXA3010	Song sparrow	Melospiza melodia	Emberizidae	Aves
ABNME08020	Sora	Porzana carolina	Rallidae	Aves
ABNNF04020	Spotted sandpiper	Actitis macularius	Scolopacidae	Aves
ABPBX74080	Spotted towhee	Pipilo maculatus	Emberizidae	Aves
ABPAV02010	Steller's jay	Cyanocitta stelleri	Corvidae	Aves
ABNKC19070	Swainson's hawk	Buteo swainsoni	Accipitridae	Aves
ABPBJ18100	Swainson's thrush	Catharus ustulatus	Turdidae	Aves
ABPBJ16010	Townsend's solitaire	Myadestes townsendi	Turdidae	Aves
ABPBX03080	Townsend's warbler	Dendroica townsendi	Parulidae	Aves
ABPAU03010	Tree swallow	Tachycineta bicolor	Hirundinidae	Aves
ABNKA02010	Turkey vulture	Cathartes aura	Cathartidae	Aves
ABNNF06010	Upland sandpiper	Bartramia longicauda	Scolopacidae	Aves
ABPBJ22010	Varied thrush	Ixoreus naevius	Turdidae	Aves
ABNUA03020	Vaux's swift	Chaetura vauxi	Apodidae	Aves
ABPBJ18080	Veery	Catharus fuscescens	Turdidae	Aves
ABPBX95010	Vesper sparrow	Pooecetes gramineus	Emberizidae	Aves
ABPAU03040	Violet-green swallow	Tachycineta thalassina	Hirundinidae	Aves
ABNME05030	Virginia rail	Rallus limicola	Rallidae	Aves
ABPBW01210	Warbling vireo	Vireo gilvus	Vireonidae	Aves
ABPBJ15020	Western bluebird	Sialia mexicana	Turdidae	Aves
ABNCA04010	Western grebe	Aechmophorus occidentalis	Podicipedidae	Aves
ABPAE52050	Western kingbird	Tyrannus verticalis	Tyrannidae	Aves
ABPBXB2030	Western meadowlark	Sturnella neglecta	Icteridae	Aves
ABNSB01040	Western screech-owl	Megascops kennicottii	Strigidae	Aves
ABPBX45050	Western tanager	Piranga ludoviciana	Thraupidae	Aves
ABPAE32050	Western wood-pewee	Contopus sordidulus	Tyrannidae	Aves
ABPAZ01020	White-breasted nuthatch	Sitta carolinensis	Sittidae	Aves
ABPBXA4040	White-crowned sparrow	Zonotrichia leucophrys	Emberizidae	Aves
ABNYF07070	White-headed woodpecker	Picoides albolarvatus	Picidae	Aves
ABNUA06010	White-throated swift	Aeronautes saxatalis	Apodidae	Aves
ABNLC14010	Wild turkey	Meleagris gallopavo	Phasianidae	Aves
ABNYF05030	Williamson's sapsucker	Sphyrapicus thyroideus	Picidae	Aves
ABPAE33040	Willow flycatcher	Empidonax traillii	Tyrannidae	Aves
ABNNF20010	Wilson's phalarope	Phalaropus tricolor	Scolopacidae	Aves
ABNNF18030	Wilson's snipe	Gallinago delicata	Scolopacidae	Aves
ABPBX16020	Wilson's warbler	Wilsonia pusilla	Parulidae	Aves
ABPBG09050	Winter wren	Troglodytes troglodytes	Troglodytidae	Aves
ABNJB09010	Wood duck	Aix sponsa	Anatidae	Aves
ABPBX03010	Yellow warbler	Dendroica petechia	Parulidae	Aves
ABPBX24010	Yellow-breasted chat	Icteria virens	Parulidae	Aves
ABPBXB3010	Yellow-headed blackbird	Xanthocephalus xanthocephalus	Icteridae	Aves
ABPBX03060	Yellow-rumped warbler	Dendroica coronata	Parulidae	Aves

APPENDIX B

STREAMLINED HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT

STREAMLINED HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT

Pyx Mine
Wallowa-Whitman National Forest, Oregon — February 2009

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ACRONYMS AND ABBREVIATIONS

cm^2	Square centimeter
cm/hr	Centimeter per hour
kg	Kilogram
L/cm^3	Liter per cubic centimeter
m^3/day	Cubic meter per day
m^3/kg	Cubic meter per kilogram
mg/cm^2/day	Milligram per square centimeter per day
mg/day	Milligram per day
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
mg/L	Milligram per liter
ABA	Acid base accounting
ALM	Adult Lead Methodology
AWQC	Ambient water quality criteria
BLM	United States Bureau of Land Management
CDI	Chronic daily intake
CERCLA	Comprehensive Environmental Response, Compensation & Liability Act
CNS	Central nervous system
COI	Contaminant of interest
COPC	Contaminant of potential concern
CPEC	Contaminant of potential ecological concern
CSEM	Conceptual site exposure model
CSM	Conceptual site model
CTE	Central tendency exposure
ECR	Excess cancer risk
EF	Exposure factor
EPA	United States Environmental Protection Agency
EPC	Exposure point concentration
ERA	Ecological risk assessment
FWS	U.S. Fish and Wildlife Service
HEAST	Health Effects Assessment Screening Tables
HHRA	Human health risk assessment
HI	Hazard Index
HQ	Hazard Quotient
IEUBK	Integrated Exposure Uptake Biokinetic
IRIS	Integrated Risk Information System
LOAEL	Lowest observed adverse effects level
MCL	Maximum contaminant level

ACRONYMS AND ABBREVIATIONS (continued)

MDC	Maximum detected concentration
MSE	Millennium Science and Engineering, Inc.
NCEA	National Center for Environmental Risk Assessment
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NFS	National Forest System
NOAEL	No observed adverse effects level
OAR	Oregon Administrative Rules
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
ONHP	Oregon National Heritage Program
PRG	Preliminary Remediation Goal
RAGS	Risk Assessment Guidance for Superfund
RAIS	Risk Assessment Information System
RfD	Reference dose
RMC	Risk Management Criteria
RME	Reasonable maximum exposure
SARA	Superfund Amendments and Reauthorization Act
SF	Slope factor
SI	Site Inspection
SLV	Screening level value
SOC	Species of concern
T&E	Threatened and endangered
TRV	Toxicity reference value
UCL_{90}	90 percent upper confidence limit

1.0 INTRODUCTION

- Streamlined human health and ecological risk assessments were completed for the Pyx Mine Site using analytical data and other information gathered during the Site Inspection (SI) and field investigation by Millennium Science and Engineering, Inc. (MSE).
  - A streamlined risk assessment focuses on and evaluates only the principal exposure pathways and significant targets of concern. The objective is to simply determine whether sufficient risk is present to warrant a removal action.
  - The streamlined process is intended to eliminate unnecessary data development and analysis, and reduce the overall effort and cost of a removal action. This approach recognizes that the elimination of all uncertainties is not possible or necessary, and uses only the data needed to generally characterize potential risks and support the development and selection of removal action alternatives.
- The purpose of the streamlined risk assessments was to assess potential hazards and risks to human and ecological receptors from exposure to mine waste and contaminated media at the Site.
- Primary objectives of the risk assessments were to:
  - Determine 90 percent Upper Confidence Limit (UCL_{90}) concentrations
  - Assess potential risks to human and ecological receptors at the Site
  - Identify hot spots, i.e. highly contaminated areas that contribute a large percentage of the overall site risk
  - Establish appropriate risk-based, site-specific, cleanup levels
- This document describes the risk assessment methodology, assumptions, and potential risks to human and ecological receptors at the Site.
  - A detailed description of the Site location, background, field investigation, and physiography is presented in the SI report and will not be reiterated here.
  - Summary tables are presented at the end of the report and human health and ecological risk calculation tables are presented in Attachments A and B, respectively.
  - A list of threatened and endangered (T&E) wildlife and plant species, as well as species of concern (SOC), is provided in the SI report.

2.0 DATA REVIEW

- Analytical results of samples collected during the field investigation were tabulated and reviewed to ensure suitability for use in the risk assessments.
- Data used in the risk assessments included results of background soil, mine waste, surface water, and sediment samples collected during the field investigation. The analytical results are presented in the SI report.
- The laboratory reporting limit (RL) for analytical results reported as below the RL were compared to human health and ecological screening criteria to ensure the RLs were below the applicable criteria.
  - The RL is the lowest concentration is the lowest concentration at which an analyte can be detected in a sample and its concentration can be reported with a reasonable degree of accuracy and precision. If the RL is above screening criteria, a sample concentration may be reported as not detected but still be above the screening criteria.
  - In surface water, the RLs for arsenic and mercury were above one or more human health and/or ecological screening criteria.
    - The arsenic RL (0.00150 milligrams per liter [mg/L]) was above the U.S. Environmental Protection Agency's (EPA) Recommended Chronic Ambient Water Quality Criterion (AWQC) for Human Consumption of Water and Fish (0.000018 mg/L, EPA 2006), and

Oregon's Human Health Water Quality Criteria, water and fish consumption (0.0000022 mg/L, Oregon Department of Environmental Quality [ODEQ] 2005).
    - The mercury RL (0.00010 mg/L) was above Oregon's Chronic AWQC for Protection of Aquatic Life (0.000012 mg/L, ODEQ 2005).
  - In waste rock and soil, the RLs for antimony and selenium exceeded one or more ecological screening criterion.
    - The antimony RL (2.0 milligrams per kilogram [mg/kg]) was above the EPA Eco-SSL (0.27 mg/kg, EPA 2005b).
    - The selenium RL (4.0 mg/kg) was above Oregon's Level II Screening Level Values (SLV, ODEQ 2001) for plants (1 mg/kg) and birds (2 mg/kg).
  - For those analytes in surface water that are hardness dependent, the criteria were adjusted based on the sample hardness (ODEQ 2001).
- The maximum detected concentration (MDC), mean concentration, and UCL_{90} of the arithmetic mean concentration were determined for the contaminants of interest (COI) in all media.
  - In determining the average and UCL_{90} concentrations, samples with undetected concentrations were conservatively included at concentrations equal to ½ the reporting limit (EPA 1991).

3.0 INITIAL RISK SCREENING

- The maximum detected COI concentrations were compared to U.S. Bureau of Land Management (BLM) Risk Management Criteria (RMC) to provide a preliminary qualitative assessment of potential risk to human and ecological receptors at the Site.
  - The RMCs were developed as a screening tool for quickly assessing overall risks to humans and wildlife at abandoned mining sites and are based on the most problematic metals (antimony, arsenic, cadmium, copper, lead, manganese, mercury, nickel, selenium, silver, zinc) typically found at abandoned mine sites, on available toxicity data, and standard EPA exposure assumptions (Ford 2004).
  - Comparing the maximum detected COI concentrations to the RMCs provides risk in logarithmic terms, with relative risk expressed in terms of the factor by which COI concentrations exceed the reference RMC.
  - This initial risk screening process is intended to provide only a general level of risk and is, therefore, independent of the streamlined quantitative risk assessments.
  - The results of the RMC screening are summarized in Table 1.

3.1 Human Health Risk Screening

- Ford (2004) developed human health RMCs for soil, sediment, and surface water based on exposure scenarios that could potentially occur at abandoned mine sites, including camper, all-terrain vehicle driver, worker, surveyor, boater, swimmer, and resident.
  - The RMCs correspond to either a target Excess Cancer Risk (ECR) of 1.E-05, or a target non-carcinogenic Hazard Index (HI) of 1.
  - For metals posing both carcinogenic and non-carcinogenic threats to health, the lower (more protective) concentration is used for the RMC. For a target ECR of 1.E-05, an individual exposed at the RMC under the BLM exposure conditions would have a 1 in 100,000 chance to develop any type of cancer in a lifetime as a result of contact with the metal of concern.
  - An HI of <1 is assigned when the dose of non-carcinogenic metals assumed to be received at the Site by any of the receptors is lower than the dose that may result in adverse non-carcinogenic health effects.
  - The RMCs are protective for exposures to multiple chemicals and media.

- Because of the limited available toxicological information regarding health risks associated with exposure to lead, the lead RMC was determined from the EPA Integrated Exposure Uptake Biokinetic (IEUBK) Model and other EPA regulations and guidance (Ford 2004).
- The RMCs apply to soil, mine waste, sediment and surface water at the Site.

- The maximum detected COI concentrations in the mine waste, background soil, sediment, and surface water samples collected during the field investigation were compared to the RMCs for the camper receptor classification.
  - Arsenic, lead and mercury were the only COIs to exceed human health RMCs.
    - The initial risk screening results, shown in Table 1, indicate a high risk to human receptors from exposure to arsenic and mercury in mine waste, and a moderate risk from exposure to lead in the mine waste.
  - There does not appear to be a human health risk from exposure to surface water or sediment at the Site.

3.2 Ecological Risk Screening

- Ford developed ecological RMCs for soil from a survey of literature for toxicity data relevant to either wildlife receptors at BLM sites or to closely related species.
  - For receptors without available toxicity data, Ford selected data based on phylogenetic similarity between ecological receptors and the test species for which toxicity data were reported. He obtained soil ingestion data for each receptor from a study on dietary soil content of wildlife from the U.S. Fish and Wildlife Service (FWS).
  - For receptors without available dietary soil content data, he assumed soil content was equal to that of an animal with similar diets and habits.
  - The amount of soil ingested by each receptor was estimated as a proportion of their daily food intake. Ford then calculated the food intake in grams for each receptor as a function of body weight based on scaling factors specific to each type of species.
- Ford calculated RMCs for metals in soil based upon assumed exposure factors (EF) for the specific receptors and species- and chemical-specific toxicity reference values (TRV).
  - The TRVs represent daily doses of the metals for each wildlife receptor that will not result in any adverse toxic effects. Ford computed the TRVs for each wildlife receptor/metal combination for which toxicity data were available.
  - Phylogenetic and intraspecies differences between test species and ecological receptors were accounted for by applying uncertainty factors derived from critical toxicity values. These uncertainty factors were applied to protect wildlife receptors that might be more sensitive to the toxic effects of a metal than the test species.
  - In accordance with this system, Ford applied a divisor of two to the toxicity reference dose for each level of phylogenetic difference between the test and wildlife species (in essence, individual, species, genus, and family).
- The maximum detected COI concentrations in the mine waste and background soil were compared to ecological RMCs for four potential receptors: deer mouse, mule deer, elk, and robin.
  - The initial mine waste screening results, shown in Table 1, indicate moderate to extremely high risk to all receptors from exposure to arsenic, cadmium, lead and mercury.
    - Copper poses a moderate risk to the mule deer and a high risk to the robin.
    - Zinc poses a moderate risk to the robin.
    - There is also moderate risk to the robin from exposure to cadmium, copper and zinc in the background soil.

4.0 STREAMLINED HUMAN HEALTH RISK ASSESSMENT

- The streamlined human health risk assessment (HHRA) was prepared to assess potential hazards and risks to human receptors from exposure to mine waste and contaminated media at the Site.
- The HHRA used analytical data and other information gathered during the field investigation by MSE in June 2008 and site-specific EFs based on the anticipated receptors and future land uses.
- Both central tendency exposure (CTE) and reasonable maximum exposure (RME) scenarios were evaluated.
- The HHRA was prepared in general accordance with state and federal regulations and guidelines, including:
  - Comprehensive Environmental Response and Compensation Liability Act (CERCLA);
  - Superfund Amendments and Reauthorization Act (SARA);
  - National Oil and Hazardous Substances Pollution Contingency Plan (NCP) 40CFR 300.415(b)(4)(i);
  - EPA's *"Risk Assessment Guidance for Superfund Volume I – Human Health Evaluation Manual Part (A)"*, (EPA 1991);
  - EPA's *"Exposure Factors Handbook"* (EPA 1997a);
  - EPA's *"Risk Assessment Guide for Superfund, Part E, Supplemental Guidance for Dermal Risk Assessment"* (EPA 2004a); and
  - ODEQ's *"Guidance for Conduct of Deterministic Human Health Risk Assessment"* (ODEQ 2000a).
- The streamlined HHRA process consisted of six steps:
  - **Step 1** – Exposure Assessment
  - **Step 2** – Toxicity Assessment
  - **Step 3** – Risk Characterization
  - **Step 4** – Uncertainty Analysis
  - **Step 5** – Hot Spot Assessment
  - **Step 6** – Development of Risk-based Cleanup Levels
- Each step is discussed in the following sections and summary tables are provided at the end of the report. Human health risk calculation tables are provided in Attachment A.

4.1 Exposure Assessment

- The exposure assessment involved:
  - Preparing a conceptual site model (CSM),
  - Identifying the potentially exposed populations at the Site,
  - Determining the potentially complete exposure pathways,
  - Identifying the contaminants of potential concern (COPC), and
  - Estimating exposure point concentrations (EPC), and developing a set of EFs and assumptions for use in the risk calculations.

4.1.1 Human Health Conceptual Site Model

- A human health CSM, shown in Figure 1, was prepared for the Site to provide a framework for assessing risk by identifying the following:
  - The environmental setting and contaminants known or suspected to exist at the Site,
  - Contaminant fate and transport mechanisms that might exist at the Site,
  - Mechanisms of toxicity associated with contaminants and potential receptors,
  - Complete exposure pathways that might exist at the Site, and

- Potential exposed populations.
- The Pyx Mine CSM was based on information gathered during preparation of the SI and should be representative of current and likely future conditions at the Site.

4.1.2 Potentially Exposed Populations

- While the Site is in a relatively remote location, there are several historic mines within a 5-mile radius of the Site, and the historic mining town of Greenhorn is about 3 miles southwest of the Site. The population of Greenhorn was reported to be 2 in 2006; however, the area is frequented by seasonal inhabitants and visitors (Cockle 2008).
- Although there are no developed recreational areas near the Site, public exploration and recreational use of the Site is likely moderate because of the large number of historic mining operations in the area and ease of access to the Site.
- Recreational uses are likely to include hiking, camping, hunting, timber harvesting, firewood cutting, and minerals prospecting.
- Future uses of the Site are expected to remain the same as current uses. Residential development of the Site is believed to be unlikely; therefore, the risk of long-term exposure to contaminants at the Site is considered low.
- Three primary receptors most likely to visit the Site were evaluated:
  - Worker – Adult Receptor
  - Recreationalist – Adult Receptor
  - Recreationalist – Child Receptor

4.1.3 Potentially Complete Exposure Routes

- Based on the anticipated receptors, the following exposure pathways were evaluated:
  - Incidental ingestion of mine waste (waste rock) and sediment;
  - Ingestion of surface water as a drinking source;
  - Dermal contact with mine waste, surface water, and sediment; and
  - Inhalation of mine waste particulates.
- Other potentially complete pathways, such as groundwater ingestion, plant ingestion, and fish tissue ingestion were qualitatively considered but not quantified.
  - The groundwater pathway at the Site is considered incomplete because there are no groundwater uses at the Site and there does not appear to be any nearby wells that are hydraulically connected to the Site.
  - Vegetation samples were not collected during the field investigation; however, no palatable species were documented on the Site. It's also unlikely that the Site will be used for agricultural cultivation; therefore, plant ingestion was determined to be a potentially complete but insignificant pathway.
  - The adit discharge does not support a viable fish habitat; therefore, risks from the ingestion of fish were not quantified.

4.1.4 Contaminants of Potential Concern

- Analytical results of mine waste, sediment, and surface water samples collected during the field investigation were screened in accordance with EPA guidance (EPA 2001) to identify COPCs.
- The screening process consisted of three steps:
  - Determining the frequency of detection
  - Comparing sample concentrations to background concentrations

    - Comparing sample concentrations to established criteria for potential toxicity
- Essential nutrients (calcium, iron, magnesium, potassium, and sodium) were not present at concentrations that would pose a threat to human health; therefore, they were screened from further analysis.
- **Frequency of Detection Screening** – COIs detected in fewer than 5 percent of the samples site-wide for a given media were eliminated from further screening.
    - All COIs except cyanide were detected in more than 5 percent of the mine waste samples.
    - Cyanide, silver, cadmium, antimony, and selenium were not detected in the sediment sample.
    - Copper and iron were the only COIs detected in the surface water sample.
- **Comparison with Background Concentration Screening** – COIs with maximum detected concentrations (MDC) below background concentrations were eliminated from further screening. Background UCL_{90} concentrations were used for mine waste; however, mean background concentrations could not be used for surface water or sediment because no background samples were collected.
    - In mine waste, all COIs except cyanide were above background and retained for further screening.
    - No background sources were available for surface water or sediment.
- **Concentration-risk Screening –** The COI MDCs were compared to the lower of: (1) EPA Region IX Industrial Soil Preliminary Remediation Goals (PRG) (2004b), and (2) Oregon Industrial Maximum Allowable Soil Concentration Cleanup Levels (ODEQ 2000b).
    - Industrial criteria were used for mine waste and sediment because there are no established criteria for a recreational use scenario and residential development of the Site is believed to be unlikely. However, it should be noted that the industrial criteria are very conservative for this site because they are typically based on an occupational scenario with 250 days of exposure per year, which is much greater than would be expected for recreational use.
    - For surface water, the MDCs were compared to the lower of (1) EPA's Recommended Chronic AWQC for human consumption of water and fish (EPA 2006), and (2) State of Oregon Human Health Water AWQC for water and fish consumption (ODEQ 2005).
    - The concentration risk screening also evaluated potential cumulative effects of individual COIs across multiple media, as well as multiple COIs within each media and across multiple media.
- In addition to risk from individual COIs in each media, the concentration-risk screening also evaluated potential cumulative effects from exposure to multiple COIs across each media, as well as from exposure to a single COI across multiple media.
    - The risk from exposure to multiple COIs across a single medium is evaluated by dividing each single COI risk ratio by the sum of risk ratios for the medium.
    - A result greater than 1 divided by the number of risk ratios indicates risk.
    - The risk from exposure to a COI across multiple media is evaluated by summing the COI's risk ratio for each medium; a total risk ratio greater than or equal to 1, indicates risk.
- Results of the screening process are summarized in Table 2.
    - Three COPCs were identified: arsenic, lead and mercury.
        - Arsenic was identified as a COPC in all media.
        - Lead and mercury were identified as COPCs in mine waste and based on exposure to multiple COIs across multiple media.

4.1.5 Exposure Point Concentrations

- The EPC is used in the risk calculations and is defined as the concentration that a receptor will potentially contact during the exposure period.

- EPCs were estimated for each COPC from the analytical results of samples collected during the field investigation.
- For the RME scenario, UCL_{90} concentrations were used for the EPC because of the uncertainty associated with estimating the true average concentration at a Site; however, because of the relatively small data sets and non-parametric data distribution, the computed UCL_{90} concentrations for some COPCs exceeded the MDC. In those instances, the MDC was used as the EPC.
- For the CTE scenario, the arithmetic mean concentration was used as the EPC for all media in accordance with EPA guidance (EPA 1991).

- The EPCs used in this HHRA are summarized in Table 3.

4.1.6 Exposure Factors and Assumptions

- EFs are assumed variables that are used with EPCs in the risk characterization equations to calculate contaminant exposures based on receptor body weight, exposure frequency and duration, averaging time, intake rates, chemical bioavailability, and other factors.
- The EFs used in the HHRA were derived from a combination of site-specific conditions and standard default values presented in risk assessment guidance documents (EPA 1997a & 2004a, ODEQ 2000a) and are summarized in Table 4.

4.2 Toxicity Assessment

- The toxicological properties of COPCs identified in the exposure assessment were evaluated to determine the types and severity of potential health hazards associated with each COPC.
- Toxicological values for use in the risk equations were obtained from:
  - EPA's Integrated Risk Information System (IRIS, EPA 2008)
  - Health Effects Assessment Summary Tables (HEAST, EPA 1997c)
  - U.S. Department of Energy's (DOE) Risk Assessment Information System (RAIS, DOE 2008)
- Although subchronic exposures may be most representative of actual exposure times at the Site, toxicity values for chronic exposure, i.e., from 7 years to a lifetime, were used to be conservative.
- The non-carcinogenic and carcinogenic toxicity values are summarized in the human health risk calculation tables in Attachment A.

4.3 Risk Characterization

- Potential non-carcinogenic hazards, carcinogenic risks, and lead risks to human receptors at the Site were estimated using the EPA risk assessment methodology and equations presented in the following subsections (EPA 1991).

4.3.1 Chronic Daily Intake

- The chronic daily intake (CDI) represents the estimated daily exposure in milligrams per kilogram per day (mg/kg-day) to a contaminant at the Site based on site-specific EFs and other parameters.
- CDIs are calculated for each exposure pathway and media using the following equations:

Ingestion:
$$CDI = \frac{CS \times IR \times EF \times ED \times CF}{BW \times AT}$$

Dermal Contact (soil): $$CDI = \frac{CS \times SA \times SSAF \times DAF \times EV \times EF \times ED \times CF}{BW \times AT}$$

Dermal Contact (water): $$CDI = \frac{CS \times SA \times Kp \times EV \times Tev \times EF \times ED \times CF}{BW \times AT}$$

Inhalation: $$CDI = \frac{CS \times IN \times EF \times ED}{BW \times AT \times PEF}$$

Where:

CS = Contaminant concentration (mg/kg or milligram per liter [mg/L])
IR = Ingestion rate (milligram per day [mg/day])
EF = Exposure frequency (day per year)
ED = Exposure duration (year)
EV = Events per day
Tev = Time per event (hour/event)
CF = Conversion factor (kg/mg or liter per cubic centimeter [L/cm^3])
BW = Body weight (kg)
AT = Averaging time (day)
DAF = Dermal absorption fraction (unitless)
SA = Skin surface area (square centimeter [cm^2])
SSAF = Soil to skin adherence factor (milligram per square centimeter per day [mg/cm^2/day])
Kp = Dermal permeability coefficient (cm/hr)
IN = Inhalation rate (cubic meter per day [m^3/day])
PEF = Particulate emission factor (cubic meter per kilogram [m^3/kg])

4.3.2 Non-carcinogenic Hazards

- Non-carcinogenic hazards are evaluated by comparing the CDIs for each exposure pathway and media with EPA-established reference doses (RfD).
  - RfDs are COPC-specific toxicological values developed by the EPA to represent route-specific estimates of the safe dosage for each COPC over a lifetime of exposure.
  - Potentially adverse health affects can occur if the CDI exceeds the RfD.
  - RfDs can be classified as chronic or subchronic depending on the length of exposure.
  - Although subchronic RfDs may be more representative of actual site conditions, chronic RfDs represent the highest average daily exposure to a human receptor that will not cause adverse health effects during their lifetime; therefore, to be conservative chronic RfDs were used.
- A non-carcinogenic Hazard Quotient (HQ) is computed for each COPC and exposure pathway by dividing the CDI by the RfD:

$$Non-carcinogenic\ HQ = \frac{CDI}{RfD}$$

Where:

CDI = Chronic daily intake; the estimated exposure over a given time
RfD = Reference dose; the exposure level above which represents potential adverse health effects

- Individual HQs are determined for all COPCs in each exposure pathway.
  - HQ or HI values greater than 1 indicate the potential for adverse health effects because the estimated intake exceeds the safe dosage (EPA 1991).
  - Oregon Administrative Rule (OAR) 340-122-0115 defines the "acceptable risk level for human exposure to non-carcinogens" as an HI of less than or equal to 1 (ODEQ 2000a).
  - Generally, if two or more COPCs have the same target organ or similar effects, their HQs are summed to determine a HI. For example, two COPCs that both have an effect on the liver would be summed into an HI.
  - If one COPC affects the liver and the other COPC affects the central nervous system (CNS), their affects are not considered additive and their HQs are usually not summed into an HI. However, when there is a carcinogenic COPC (such as arsenic) at high concentrations, carcinogenic risk will typically drive the human health risk and non-carcinogenic hazards will not be a factor.
  - Therefore, because arsenic is present at relatively high concentrations at this Site, the individual HQs were conservatively summed into an HI without regard for the target organ.

4.3.3 Carcinogenic Risks

- The carcinogenic risk from exposure to a COPC is expressed in terms of the probability that an exposed receptor will develop cancer over their lifetime.
- Carcinogenic risks are estimated by multiplying the CDIs by COPC-specific slope factors (SF) developed by the EPA:

$$Carcinogenic\ Risk = CDI \times SF$$

Where:

CDI = Chronic daily intake averaged over a lifetime; i.e., the estimated lifetime exposure at the Site
SF = Slope factor; the upper-bound estimate of probability of cancer per unit of intake over a lifetime

- The SF converts the contaminant intake to a risk of developing cancer from the exposure (i.e., ECR). SFs are chemical- and route-specific and represent an upper bound individual lifetime ECR.
  - The ECR from each COPC in an exposure pathway are summed to determine the cumulative risk for each pathway and the cumulative risks from each pathway are summed to determine the overall site risk.
  - ECRs greater than 1.E-06 indicate carcinogenic risk; however, the EPA suggests considering a range of ECRs from 1.E-06 to 1.E-04 when determining whether risks warrant a removal action (EPA 1991).
  - OAR 340-122-0115 defines the "acceptable risk level for human exposure to individual carcinogens" as an ECR of less than or equal to 1.E-06 (ODEQ 2000a).

4.3.4 Lead Risks

- Risks from exposure to lead cannot be quantified using standard risk assessment algorithms because the EPA has not established lead RfDs and SFs.
- The EPA currently recommends two models (IEUBK and Adult Lead Methodology [ALM]) for assessing lead risk based on the receptor age group; however, both models were developed to assess exposures under chronic, steady-state conditions such as a working environment, school, or residence (EPA 2002 and 2005a).
  - The models are not intended to be used for acute, short-term exposures such as those associated with occasional recreational use of a remote site.
  - Because exposures at the Site are expected to be short-term and occasional, the lead exposure models were not used and lead risks were not quantitatively evaluated.
- Therefore, lead risks were qualitatively evaluated by comparing the maximum detected lead concentrations at the Site to EPA and Oregon State screening criteria.
  - Two mine waste samples from the tailings impoundment contained lead concentrations above EPA's Industrial Soil PRG (800 mg/kg, EPA 2004b); however, both samples were well below Oregon's Industrial Maximum Allowable Soil Concentration Cleanup Level (2,000 mg/kg, ODEQ 2000b). Therefore, lead does not appear to pose a human health risk at the Site.

4.4 Uncertainty Analysis

- The estimates of exposure, non-carcinogenic hazard, and carcinogenic risk presented in this HHRA are subject to varying degrees of uncertainty from a variety of sources, including site data, exposure assessment, and risk characterization.

4.4.1 Site Data

- The size of the data set, sample locations, and sample analyses can all contribute uncertainty to the risk assessment.
  - In general, smaller data sets lend more statistical variability to estimates of contaminant concentrations and may over- or underestimate the true mean or maximum concentration.
  - Also, background concentrations were based on very small data sets (four or fewer samples) and may not be representative of actual background conditions. Use of these background concentrations to screen COIs may result in screening out potential contaminants that could be above true background levels.
- The intent of sampling during a field investigation is typically to determine metals concentrations in areas of suspected contamination, such as mine waste piles and adit discharges.
  - Based on the methodology used for sample collection during the field investigation, the samples are expected to be biased to the highest concentrations present on the Site and do not represent an average Site concentration. Therefore, exposure doses based on the results of these non-random samples are expected to be biased to the upper end of the range of exposures at the Site.
- The analytical suite was limited to COIs typically found at other mine sites in the region; risks from exposure to organics at this Site were not characterized in this HHRA.

4.4.2 Exposure Assessment

- Many of the factors used to estimate exposure rates at the Site are standard assumptions based on EPA HHRA guidance values and may not accurately describe future site conditions or uses.
  - The assumed receptors were limited to an adult worker and adult and child recreationalists.
  - The recreational exposure frequencies are based on very limited use because of the remoteness of the Site and the absence of nearby developed recreational areas. However, the assumed exposure duration of 30 years for the adult under the RME scenario may overestimate actual use since it is unlikely that a recreationalist will revisit the Site for 30 consecutive years.
- The anticipated recreational activities do not generally result in significant dermal contact or ingestion of sediment. Inclusion of these exposure pathways likely contributes additional conservatism to the HHRA.
- It is inherently assumed that future COPC concentrations will remain the same as current concentrations.

4.4.3 Toxicity Assessment

- Uncertainties are inherent in toxicity factors because of several factors, including statistical extrapolation, population variability, and limited biological and epidemiological studies. These uncertainties may contribute to under- or overestimation of potential risks and hazards.

4.4.4 Risk Characterization

- The standard algorithms used to calculate the contaminant intakes and associated health risks and hazards add uncertainty to the risk assessment.
  - The algorithms assume the additivity of toxic effects for multiple contaminants and do not account for synergistic or antagonistic effects.
  - Concurrent exposure to multiple pathways by a single receptor and the associated cumulative risks and hazards also is assumed which likely overestimates actual exposures.
  - The algorithms also do not account for factors such as absorption or matrix effects.

4.4.5 Lead Risk

- Because of the lack of established quantitative reference data for lead, potential health risks from exposure to lead at the Site were not quantified; therefore, the potential risks were qualitatively evaluated by comparing lead concentrations in mine waste and surface water samples to suggested screening values and may or may not be representative of actual risks.
  - The EPA screening value (Region IX Industrial Soil PRG EPA 2004b) is based on a worker scenario with 250 days of exposure and application of this screening level should provide a very conservative estimate of lead risk at the Site where the adult recreationalist exposure is based on 30 days per year under the RME scenario.

4.5 Summary of Potential Human Health Risks

- The estimated non-carcinogenic hazards and carcinogenic risks from exposure to COPCs at the Site are summarized in Table 5.
  - The estimated non-carcinogenic hazards were compared to the EPA and Oregon acceptable level of HI $\leq$ 1 (EPA 1991, ODEQ 2000a).
    - The results indicate minimal (i.e. HI $\leq$ 1) non-carcinogenic hazard for all receptors under

both the CTE and RME scenarios.

- The estimated carcinogenic risks from exposure to COPCs at the Site were compared with EPA's suggested screening ECR range of 1.E-06 to 1.E-04 (EPA 1991), and ODEQ's acceptable carcinogenic risk level of ≤ 1.E-06 for a single carcinogen (ODEQ 2000a).
  - The results indicate minimal carcinogenic risk (<1.E-06) under the CTE scenario, and a moderate carcinogenic risk to all receptors under the RME scenario.
  - The total cumulative ECR for the child recreationalist was 1.E-05 under the RME scenario.
  - The total cumulative ECR for the adult recreationalist was 8.E-06 under the RME scenario.
  - The total cumulative ECR to the adult worker was 8.E-05 under the RME scenario.

- Incidental ingestion of and dermal contact with arsenic in the mine waste are the most significant exposure pathways and contribute the majority of carcinogenic risk at the Site.
  - Dermal contact with and ingestion of surface water and sediment, and inhalation of particulates from the mine waste contributed minimally to the overall risk and, therefore, are not considered to be significant exposure pathways at the Site.
- Human health risks resulting from exposure to lead at the Site were not quantified because: (1) the EPA has not established quantitative reference data for lead, and (2) the current lead exposure models are based on chronic long-term exposures and are not intended for assessing risk from occasional short-term exposures.
  - Therefore, the potential risks from exposure to lead were qualitatively evaluated by comparing lead concentrations in mine waste, sediment, and surface water samples to establish suggested screening levels for the protection of human health.
    - The EPA has not specified a hazardous waste threshold value for total lead in soil and has not established a drinking water maximum contaminant level (MCL) for lead; however, it suggests lead screening levels of 800 mg/kg for industrial soils and 15 micrograms per liter (μg/L) for drinking water (EPA 2004b).
    - The maximum detected lead concentration in mine waste at the Site was 1,210 mg/kg, which is above the EPA Region IX Industrial Soil PRG of 800 mg/kg (EPA 2004b), but well below Oregon's Industrial Maximum Allowable Soil Concentration Cleanup Level of 2,000 mg/kg (ODEQ 2000b).
    - In sediment, the lead concentration was only 2.9 mg/kg, which is well below the screening level.
    - In surface water, lead was not detected in the sample.
    - There does not appear to be a significant human health risk from exposure to lead at the Site.

4.6 Hot Spot Assessment

- Hot spots are defined by Oregon's Environmental Cleanup Rules (OAR 340-122) as areas where the contamination is "highly concentrated, highly mobile, or cannot be reliably contained" (ODEQ 1998).
  - These hot spots often cover a relatively small area but contribute to a large percentage of the overall site contamination and exposure risk.
  - OAR 340-122 also defines "highly concentrated" as concentrations corresponding to a non-carcinogenic HQ of 10 or an ECR of 1E-04 (ODEQ 2000a).
- Results of the HHRA indicate potential significant human health risks at the Site from exposure to arsenic in the mine waste; therefore, a hot spot assessment was conducted to identify specific areas contributing a large percentage of the overall site risk.

- A hot spot concentration for arsenic in mine waste was back-calculated using the HHRA risk equations and an acceptable ECR of 1.E-04 and a non-cancer HI of 10 for the most sensitive receptor (adult worker). The hot spot risk levels (HI = 10 and ECR = 1.E-04) are entered into the risk equations and a corresponding hot spot arsenic concentration is back-calculated.
- The arsenic hot spot concentration for soil at the Site was calculated to be 460 mg/kg.
- Areas where mine waste samples contained arsenic concentrations exceeding the calculated hot spot concentrations are considered to be hot spots.
- No mine waste samples exceeded the arsenic hot spot concentration and no areas were identified as hot spots at the Site.

4.7 Human Health Risk-based Cleanup Levels

- Because results of the HHRA indicated potential significant human health risks at the Site, a risk-based cleanup level for arsenic was developed for mine waste at the Site.
- A cleanup level for arsenic in mine waste was back-calculated using the HHRA risk equations and an acceptable non-carcinogenic HI of $\leq$ 1 and a carcinogenic ECR of 1.E-05 for the most sensitive receptor (adult worker) under the RME scenario. The cleanup risk level (HI = 1 and ECR = 1.E-05) is entered into the risk equations and a corresponding arsenic cleanup concentration is back-calculated.
- No cleanup levels were established for surface water because they typically default to state or federal water quality criteria, such as EPA MCLs, and surface water does not pose a human health risk at the Site. Similarly, cleanup levels were not established for sediment at the Site.
- The risk-based cleanup level is summarized in Table 6.
  - Arsenic was above the mine waste cleanup level (46 mg/kg) in a total of five mine waste samples from two different areas:
    - Waste rock pile WR1, maximum detected arsenic concentration = 62.9 mg/kg
    - Tailings impoundment, maximum detected arsenic concentration = 364 mg/kg

5.0 STREAMLINED ECOLOGICAL RISK ASSESSMENT

- A streamlined ecological risk assessment (ERA) was completed to assess potential risks to ecological receptors from exposure to waste rock and contaminated media at the Site.
- The ERA was conducted in general accordance with state and federal regulations and guidelines, including:
  - CERCLA;
  - SARA;
  - NCP 40CFR 300.415(b)(4)(i);
  - EPA's *"Risk Assessment Guidance for Superfund Volume II – Environmental Evaluation Manual,"* (2001);
  - EPA's *"Region 10 Supplemental Ecological Risk Assessment Guidance for Superfund,"* (1997b);
  - EPA's *"Guidelines for Ecological Risk Assessment"* (EPA 1998);
  - ODEQ's *"Guidance for Ecological Risk Assessment,"* (2001); and
  - Oregon Administrative Rules (OAR) 340-122-084, Sections 010 through 115.
- The streamlined ERA consists of two levels:
  - **Level 1 Scoping ERA:** Qualitatively determines whether there are potential ecological receptors or exposure pathways at the Site and involves examining the ecological setting and identifying sensitive environments, T&E species, and ecological stressors.
  - **Level 2 Screening ERA**: Involves reviewing exposure pathways and receptors present at the

Site, determining assessment and measurement endpoints, identifying contaminants of potential ecological concern (CPEC), calculating EPCs, characterizing ecological risks, and evaluating uncertainties associated with the ERA.

5.1 Level 1 Scoping Ecological Risk Assessment

- The objective of the Level 1 Scoping ERA is to qualitatively determine whether there are any potential ecological receptors or exposure pathways at the Site.
- It requires an examination of the ecological setting of the Site, presence of sensitive environments, presence of T&E species, ecological stressors (i.e., COIs), and the development of an ecological Conceptual Site Exposure Model (CSEM).
- The Level 1 Scoping ERA consisted of three steps:
  - **Step 1** – Identify ecological setting, sensitive environments, and T&E species
  - **Step 2** – Identify COIs
  - **Step 3** – Develop an ecological CSEM

5.1.1 Ecological Setting, Sensitive Environments, and T&E Species

- Ecological setting:
  - Located in the Wallowa-Whitman National Forest within the Blue Mountains Ecoregion, in a small drainage that ranges in elevation from 5,600 to 5,800 feet amsl. The Site is dry and there is no flowing water; however, there is a seasonal wet meadow south of the Site about 200 feet from the tailings impoundment.
  - Terrestrial habitats in vicinity of the Site include moderate convex slopes.
  - An ODEQ ecological scoping checklist was completed by MSE during the field investigation conducted in June 2008 and is included in Attachment C.
- Sensitive Environments:
  - A sensitive environment is defined in OAR 340-122-115 as, "an area of particular environmental value where a hazardous substance could pose a greater threat than in other non-sensitive areas. Sensitive environments include but are not limited to: critical habitat for federally endangered or threatened species; National Park, Monument, National Marine Sanctuary, National Recreational Area, National Wildlife Refuge, National Forest Campgrounds, recreational areas, game management areas, wildlife management areas; designated federal Wilderness Areas; wetlands (freshwater, estuarine, or coastal); wild and scenic rivers; state parks; state wildlife refuges; habitat designated for state endangered species; fishery resources; state designated natural areas; county or municipal parks; and other significant open spaces and natural resources protected under Goal 5 of Oregon's Statewide Planning Goals."
    - Based on this definition, there are no sensitive environments within 2 miles of the Site.
- T&E Species:
  - T&E species are those listed as threatened or endangered under the federal Endangered Species Act 16 U.S.C. Section 1533, or classified as threatened or endangered by the State Fish and Wildlife Commission under Oregon Revised Statute 496.171-496.192.
  - Information regarding T&E species and SOC for wildlife and plant species occurring in Blue Mountains Ecoregion was obtained from the Oregon Department of Fish and Wildlife (ODFW 2008) and the Oregon National Heritage Program (ONHP 2007).
    - Animal and plant species listed as T&E within the Wallowa-Whitman National Forest and specifically Grant County are listed in Attachment B and include the bald eagle and the Canada lynx.

- No T&E species are documented as inhabiting the Site and none were observed during the field investigation conducted by MSE in June 2008. Additionally, because of the small size of the Site, it is likely the Site represents little more than a fraction of the aforementioned species' habitat.

5.1.2 Contaminants of Interest

- Identification of COIs for ecological receptors requires a separate process than used for the HHRA because while some contaminants may not present a risk to human health, they may pose an ecological risk.
- A preliminary list of COIs was identified based on analytical results and a potential risk to ecological receptors: antimony, arsenic (V and total), cadmium, chromium (total), copper, iron, lead, mercury, nickel, selenium, silver, and zinc.
- During the Level 2 Screening ERA discussed in Section 5.2, COIs are examined further to identify CPECs posing risk to ecological receptors at the Site.

5.1.3 Ecological Conceptual Site Exposure Model

- An ecological CSEM illustrates the general understanding of the sources of contamination, release and transport mechanisms, impacted exposure media, potential exposure routes, and ecological receptors at the Site.
- Like the human health CSM, the CSEM provides a framework for assessing risk by identifying the following:
  - Environmental setting and contaminants known or suspected to exist at the Site
  - Contaminant fate and transport mechanisms at the Site
  - Mechanisms of toxicity associated with contaminants and potential receptors
  - Complete exposure pathways the Site
  - Potentially exposed populations
- The Pyx Mine CSEM, shown in Figure 2, is intended to be representative of current and likely future conditions at the Site.
  - The primary source of CPECs at the Site is the waste rock piles.
    - Precipitation could result in the following release/transport mechanisms from the piles of waste rock: runoff, leaching, percolation, or infiltration into surface soils, subsurface soils, or groundwater.
  - Therefore, waste rock and soil are the principal potential exposure media at the Site.

– Because of the intermittent presence of surface water in the wet meadow, there is also a slight chance of exposure to contaminated surface water and sediment at the Site.

5.2 Level 2 Screening Ecological Risk Assessment

- The Level 2 Screening ERA involves evaluating data collected during the field investigation and identifying those contaminants and media that pose potential risks to ecological receptors at the Site.
- The Level 2 Screening ERA consisted of six steps:
  - **Step 1** – Summarizing the potential exposure pathways and receptors present at the Site
  - **Step 2** – Identifying assessment and measurement endpoints
  - **Step 3** – Calculating EPCs
  - **Step 4** – Identifying CPECs

- **Step 5** – Characterizing ecological risks
- **Step 6** – Evaluating uncertainties

5.2.1 Potential Exposure Pathways and Receptors

- Potential ecological exposure pathways at the Site and evaluated in this ERA include:
  - Incidental ingestion of soil (waste rock) and sediment;
  - Direct contact with soil (waste rock), sediment, and surface water; and
  - Ingestion of surface water.
- Potential ecological receptors at the Site are expected to include terrestrial wildlife (plants, birds, invertebrates, reptiles and amphibians, and mammals) and aquatic invertebrates. Fish are not expected onsite because the Site does not provide viable fish habitat.

5.2.2 Ecological Endpoints

- Identification of ecological endpoints guides the completion of the risk characterization portion of the ERA.
- Assessment and measurement endpoints for this ERA were developed based on the CSEM for the Site.
  - The EPA defines an assessment endpoint as a "formal expression of an actual environmental value to be protected… an environmental value which would indicate a need for remediation."
    - The assessment endpoints for this ERA included survival and reproductive success of terrestrial receptors (invertebrates, birds, mammals, and vegetation).
  - The EPA defines a measurement endpoint as a "quantitative expression of an observed or measured effects of a hazard; and, these measurable environmental characteristics are related to the valued characteristics chosen as assessment endpoints."
    - Typically, the measurement endpoint will dictate the type of samples and/or data to be collected and assessed to address the affect of stressors on the ecological receptors.
    - However, because the data has already been collected, the measurement endpoint for this ERA consisted of a comparison of the measured concentrations of the COIs in soil, waste rock, surface water, and sediment to their respective ecological risk-based screening level values (SLV).

5.2.3 Exposure Point Concentrations

- Ecological receptors do not experience their environment on a "point" basis; therefore, it is necessary to convert measured data from single sample points into an estimate of concentration over their habitat to conduct an appropriate risk screening.
  - For this ERA, EPCs were based on either the MDC or UCL_{90} concentration from the analytical results, depending on the ecological receptor as suggested by ODEQ ecological risk assessment guidance (2001) and are as follows:
    - For invertebrates (such as worms) and plants, the MDC was used as the EPC, and
    - For birds, aquatic life, and mammals, the UCL_{90} was used as the EPC.
    - In some cases, because of the small sample number, the UCL_{90} was unable to be calculated. In those cases, the MDC was used as the EPC.

5.2.4 Contaminants of Potential Ecological Concern

- The COIs identified in the Level 1 Scoping ERA were screened through four processes to identify CPECs:
  - Preliminary screening
  - Chemistry-toxicity screening
  - Bioaccumulation screening
  - SLV availability screening

5.2.4.1 Preliminary Screening

- In accordance with EPA guidance (1997b) and ODEQ guidance (2001), the COIs identified in the Level 1 Scoping ERA were screened and removed from further analysis if they exhibited one or more of the following characteristics:
  - Qualified as an essential nutrient and did not have a media-specific ODEQ Level II SLV (ODEQ 2001),
  - Were detected in fewer than 5 percent of the samples by media type, or
  - Were present in concentrations below background concentrations.
- The preliminary screening results are summarized in Tables 7 through 10.

5.2.4.2 Chemistry-toxicity Screening

- COIs remaining following the preliminary screening were subjected to chemistry-toxicity screening which involved assessing potential ecological risks by comparing the EPCs to ecological risk-based SLVs.
- When available, SLVs were obtained from ODEQ's Level II SLVs for Plants Invertebrates, and Wildlife (2001). SLVs were also obtained from the EPA for comparison.
- A chemistry-toxicity screen was performed based on the following conditions:
  - Exposure to a single COI in an exposure medium,
  - Exposure to multiple COIs in an exposure medium, and
  - Exposure to individual COIs in multiple exposure media.
- Potential ecological risk from exposure to a single COI in an exposure medium was assessed by calculating contaminant-specific risk ratios (T_{ij}). Risk ratios for each COI were calculated using the following equation:

$$T_{ij} = \frac{C_{ij}}{SLV_{ij}}$$

Where:

T_{ij} = Risk ratio of COI *i* in medium *j*
C_{ij} = Contaminant concentration of COI *i* in medium *j* (mg/kg or mg/L)
SLV_{ij} = Screening level value for COI *i* in medium *j* (mg/kg or mg/L)

- The risk ratios were compared to receptor-specific risk ratios (Q-factors) to evaluate potential ecological risk.
  - In general, higher risk ratios present a greater likelihood that a CPEC concentration will adversely affect ecological receptors.
  - Risk ratios greater than 1 (Q > 1) indicate potential risk for protected (i.e., federally listed) T&E species.

- Risk ratios greater than 5 (Q > 5) indicate potential risk to non-protected receptors.
- No T&E species are documented as inhabiting the Site and none were observed during the field investigation conducted by MSE in June 2008; therefore, a Q-factor of 5 was used for mammals, birds, plants, invertebrates, and aquatic life.

If $T_{ij} \geq Q$ retain COI *i* as a CPEC in medium *j*, where:

T_{ij} = Risk ratio of COI *i* in medium *j*
Q (Receptor-specific risk ratio) = 5 for non-protected species (invertebrates, birds, mammals, and aquatic life)

- For exposure to multiple COIs in a single exposure medium, the potential ecological risk was assessed by calculating the ratio of a contaminant-specific risk ratio to the overall risk (sum of all contaminant-specific risk ratios) presented in a medium:

If $\frac{T_{ij}}{T_i} \geq \left(\frac{Q}{N_{ij}} \right)$ retain COI *i* as a CPEC in medium *j*

Where:

T_{ij} = Risk ratio of COI *i* in medium *j*
T_j = Sum of risk ratios (T_{ij}) from all COIs to each receptor group
Q = Receptor-specific risk ratio, = 5 for non-protected species
N_{ij} = Number of COIs with risk ratios (T_{ij}) for each receptor group

- If a COI was detected in multiple media, it was retained as a CPEC if the sum of risk ratios exceeded the receptor-specific risk ratio:

If $\sum_{j=1}^{j} T_{ij} \geq Q$ retain COI *i* as a CPEC

Where:

T_{ij} = Risk ratio of COI *i* in medium *j*
Q = Receptor-specific risk ratio, = 5 for non-protected species

- The results of the chemistry-toxicity screen are presented in the ecological risk calculation tables in Attachment B, and summarized below according to exposure media. The screening results and identified CPECs are presented in Tables 7 through 10.
  - **Waste rock:** Four CPECs were identified in waste rock from single COI risk ratios: iron, lead, mercury, and selenium. Iron and mercury also showed risk from multiple COIs. Five additional CPECs were retained because of the lack of SLVs: antimony, arsenic (V and total), chromium total, and silver.
  - **Surface Water:** No CPECs were identified in surface water from single or multiple COI risk ratios.
  - **Sediment:** Only zinc was identified as a CPEC in sediment; however, arsenic (total) and mercury were retained as CPECs because of the lack of SLVs.

5.2.4.3 Bioaccumulation Screening

- According to OAR 340-122-084(3)d, special attention must be given to COIs that are, or are suspected of being, persistent bioaccumulative toxins (such as mercury).
- Bioaccumulative toxins can compromise food chains and induce adverse effects in higher trophic level species.
- In the suite of COIs identified for this ERA, metals with the most bioaccumulative potential in each medium include the following:
  - Waste rock: cadmium, copper, mercury, selenium, silver, and zinc
  - Sediment: zinc
  - Surface water: copper

5.2.4.4 SLV Availability Screening

- In some instances, SLVs were not available for a given COI-media-receptor combination.
- Because estimating the toxicity or bioaccumulative potential of the COI was not possible, the COI was retained as a potential CPEC.
- The COIs retained as CPECs because of the lack of SLVs are shown in Tables 7 through 10.

5.3 Ecological Risk Characterization

- The results of the CPEC screening discussed above provide an approximate level of potential ecological risk at the Site.
- Risk characterization is comprised of describing the risks to ecological receptors and the uncertainties in the ERA.
  - The objective of the ecological risk description is to assess whether the predicted risks are likely to occur at the Site.
  - The objective of the uncertainties analysis is to examine the data gaps or sources of variability in the ERA process and whether these uncertainties underestimate or overestimate the ecological risks at the Site. The uncertainty evaluation is described in Section 5.4 of this report.
- The ecological risk ratio calculations are presented in Attachment B, and the results are summarized in Table 11.

5.3.1 Mine Waste

- Ecological risk calculations for mine waste at the Site indicate the following:
  - Iron, lead, and mercury are the most significant CPECs because they pose a potential threat to more than one ecological receptor group.
  - Based on an acceptable risk ratio of Q = 5 for non-protected species, no CPECs were determined to pose a potential threat to mammals.
    - Five CPECs were identified for mammals because of the lack of SLVs: arsenic (V and total), chromium (total), iron, and silver.
  - Two CPECs pose a risk ratio to birds based on an acceptable risk ratio of Q = 5 for non-protected species: lead (Q = 65) and mercury (Q = 100).
    - Six CPECs were identified for birds because of the lack of SLVs: antimony, arsenic (V and total), chromium (total), iron, and silver.
  - Two CPECs pose a risk ratio to invertebrates based on an acceptable risk ratio of Q = 5 for non-protected species: iron (Q = 143) and mercury (Q = 3,750).

    - Four additional CPECs were identified for invertebrates because of the lack of SLVs: antimony, arsenic (V and total), and chromium (total).
  - Four CPECs pose a risk to plants based on an acceptable risk ratio of Q = 5 for non-protected species: iron (Q = 2,850), lead (Q = 24), mercury (Q = 1,250), and selenium (Q = 6).
    - Three additional CPECs were identified for plants because of the lack of SLVs: arsenic (V and total), and chromium (total).
  - Iron posed a multiple COI risk to plants and mercury posed a multiple COI risk to invertebrates.
    - No other CPECs posed a multiple COI risk to receptors.

5.3.2 Surface Water

- Ecological risk calculations for surface water at the Site indicate the following:
  - Based on an acceptable risk ratio of Q = 5 for non-protected species, no CPECs were identified in surface water as posing a risk to birds, mammals, or aquatic life from single or multiple COI risk ratios.

5.3.3 Sediment

- Ecological risk calculations for sediment at the Site indicate the following:
  - Zinc was identified as posing a risk of bioaccumulation in aquatic life based on an acceptable risk ratio of Q = 5 for non-protected species (Q = 11)
    - Arsenic (total) was retained as both a freshwater sediment and bioaccumulation CPEC because of the lack of SLVs.
    - Mercury was retained as a bioaccumulation CPEC because of the lack of an SLV.
  - No other CPECs were identified as posing a risk from direct exposure or bioaccumulation.

5.4 Uncertainty Evaluation

- There are several sources of potential uncertainty associated with this ERA.
  - These sources and their potential impact on the prediction of potential risks to ecological receptors at the Site are discussed below.

5.4.1 Sample Data

- The selection of sampling media, sample locations, quantity of samples, sampling procedures, and sample analysis introduce some uncertainties into this ERA.
  - Time and monetary restraints limit the number of samples that can be collected; therefore, sample locations are selected based on knowledge of anticipated presence of particular contaminants.
  - Overall, the data used in this ERA were generally collected from areas with expected elevated metals concentrations. As a result, this assessment likely overestimates the risk posed to ecological receptors at the Site.

5.4.2 Screening Level Values

- The ecological risk-based SLVs used in this ERA are intended to be no-observed-adverse-effects-levels (NOAEL), with the exception of sediment SLVs.
- Ecological effects occur at some concentration between the NOAELs and the lowest-adverse-

effects-levels (LOAEL); therefore, concentrations exceeding the SLV do not necessarily constitute a "real" risk for ecological receptors.
    - Thus, use of NOAEL-based SLVs results in an overestimation of actual ecological risks at the Site.
- The lack of established SLVs for several COIs was another source of uncertainty in the ERA. COIs retained as CPECs because of the lack of SLVs rather than because of high-risk ratios may result in an overestimation of the overall potential for ecological risk at the Site.

5.4.3 CPEC Selection

- No surface water or sediment background samples were collected; thus, no CPEC background concentration screening for sediment was conducted.
- As a result, inclusion of contaminants that may actually be below background levels during the screening process may result in overestimating actual risks.
- In addition, the use of the MDC or UCL_{90} as the EPC may inherently introduce conservatism and contribute to overestimation of risk at the Site.

5.4.4 Home Range

- The use of SLVs assumes that the receptor's habitat is restricted to the affected area represented by the EPC.
    - These areas typically offer lower habitat quality compared to adjoining habitat and it is unlikely that a receptor would limit its habitat strictly to these areas.
    - The home range for most birds and mammals covers an area much larger than the Site.
- Because of the relatively small area of the piles of waste rock, the use of the SLVs likely overestimates the actual risk.

5.5 Summary of Potential Ecological Risks

- Results of the streamlined ERA indicate potential risk to ecological receptors at the Site from all media.
- Risks from mine waste:
    - Plants are the most susceptible ecological group to metal concentrations in the soil and waste rock piles.
        - The primary CPECs for the soil-plant combination exhibit elevated concentrations across the Site or have the potential to bioaccumulate and include iron, lead, mercury, and selenium.
        - The metal with the highest risk ratio and thus poses the highest risk to plants was iron (Q = 2,850)
        - Arsenic (V and total) and chromium total were retained as CPECs because of the lack of SLVs.
    - The primary CPECs for terrestrial invertebrates are iron and mercury.
        - Mercury poses the highest risk to terrestrial invertebrates (Q = 3,750).
        - Antimony, arsenic (V and total), and chromium total were retained CPECs because of the lack of SLVs.
    - The primary CPECs for birds are lead and mercury.
        - Mercury poses the highest risk to birds (Q = 100).
        - Antimony, arsenic (V and total), and chromium total were retained CPECs because of the lack of SLVs.

- Risk posed to mammals from exposure to mine waste is not elevated (Q < 5).
  - However, five metals (arsenic [V and total], chromium total, iron, and silver) were retained as CPECs because of the lack of SLVs.
- Risks from surface water:
  - Risk posed to birds, mammals, and aquatic life from exposure to contaminated surface water is not elevated (Q < 5).
- Risks from sediment:
  - Only zinc was identified as posing a risk to aquatic receptors from bioaccumulation.
    - No CPECs were identified as posing a risk to aquatic receptors from direct exposure.
  - Arsenic (total) and mercury were also retained as CPECs because of the lack of SLVs.
- The risks identified as part of this assessment appear to be limited to individual receptors and there does not appear to be significant population-level risks.
  - While individual receptors may be at risk from exposure to CPECs at the Site, their populations are unlikely to be significantly impacted in the vicinity of the mine because it is unlikely that entire populations would reside entirely within the contaminated areas of the Site.
  - In the case of mammals, birds, and terrestrial invertebrates, it should be noted that these affected areas typically offer lower habitat quality compared to adjoining habitat; therefore, it is unlikely that a receptor would limit its habitat strictly to these areas.

6.0 CONCLUSIONS

- Results of the streamlined RAs indicate potential risks to both human and ecological receptors at the Site.
- The HHRA indicates carcinogenic risk from exposure to arsenic in the mine waste at the Site.
  - Three human health COPCs were identified: arsenic, lead and mercury.
  - The most significant exposure pathway is ingestion of and dermal contact with the mine waste.
  - Inhalation of particulates from the mine waste, incidental ingestion and dermal contract with surface water and sediment at the Site contribute minimal risk and are insignificant pathways.
- A hot spot assessment was completed and a hot spot concentration for arsenic in soil was back calculated using the human health risk equations based on the most sensitive receptor (adult worker) under the RME scenario and a hot spot carcinogenic risk level of 1.E-04 for total cumulative risk.
  - No mine waste samples exceeded the arsenic hot spot concentration of 460 mg/kg.
- A human health risk-based cleanup level was calculated for arsenic in soil based on the most sensitive receptor (adult worker) under the RME scenario and an acceptable carcinogenic risk level of 1.E-05 for total cumulative risk.
  - Five mine waste samples from two areas exceeded the arsenic cleanup level of 46 mg/kg:
    - Waste rock pile WR1, maximum detected arsenic concentration = 62.9 mg/kg
    - Tailings impoundment, maximum detected arsenic concentration = 364 mg/kg
- Removal of mine waste with arsenic concentrations exceeding the cleanup level should significantly reduce both the overall human health and ecological risk at the Site.
  - The total volume of waste rock in the two areas exceeding cleanup levels is estimated to be about 3,740 bank cubic yards (bcy).
- Results of the streamlined ERA indicate significant potential risk to plants, terrestrial invertebrates, birds, and aquatic life at the Site; however, there does not appear to be a risk to mammals.
  - Risks appear to be limited to individual receptors rather than whole populations. This is

because: (1) the home range for most receptors is significantly larger than the Site and it is improbable that entire populations of receptors reside strictly within the Site bounds, and (2) the site likely represents suboptimal habitat compared to the surrounding area.

- Several CPECs were identified and the highest risk ratios for plant and terrestrial invertebrates are from exposure to iron and mercury in the mine waste.
- There is also potential risk to birds from exposure to lead and mercury in the mine waste and aquatic receptors from bioaccumulation of zinc in the adit discharge sediment.

DISCLAIMER

This abandoned mine/mill site was created under the General Mining Law of 1872 and is located solely on National Forest System (NFS) lands administered by the Forest Service. The United States has taken the position and courts have held that the United States is not liable as an "owner" under CERCLA Section 107 for mine contamination left behind on NFS lands by miners operating under the 1872 mining law. Therefore, USFS believes that this Site should not be considered a "federal facility" within the meaning of CERCLA Section 120 and should not be listed on the Federal Agency Hazardous Waste Compliance Docket. Instead, this Site should be included on EPA' CERCLIS database. Consistent with the June 24, 2003 OECA/FFEO "Policy on Listing Mixed Ownership Mine or Mill Site Created as a Result of the General Mining Law of 1872 on the Federal Agency Hazardous Waste Compliance Docket," we respectfully request that the EPA Regional Docket Coordinator consult with the Forest Service and EPA Headquarters before making a determination to include this Site on the Federal Agency Hazardous Waste Compliance Docket.

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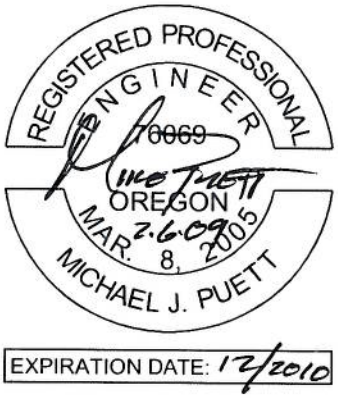

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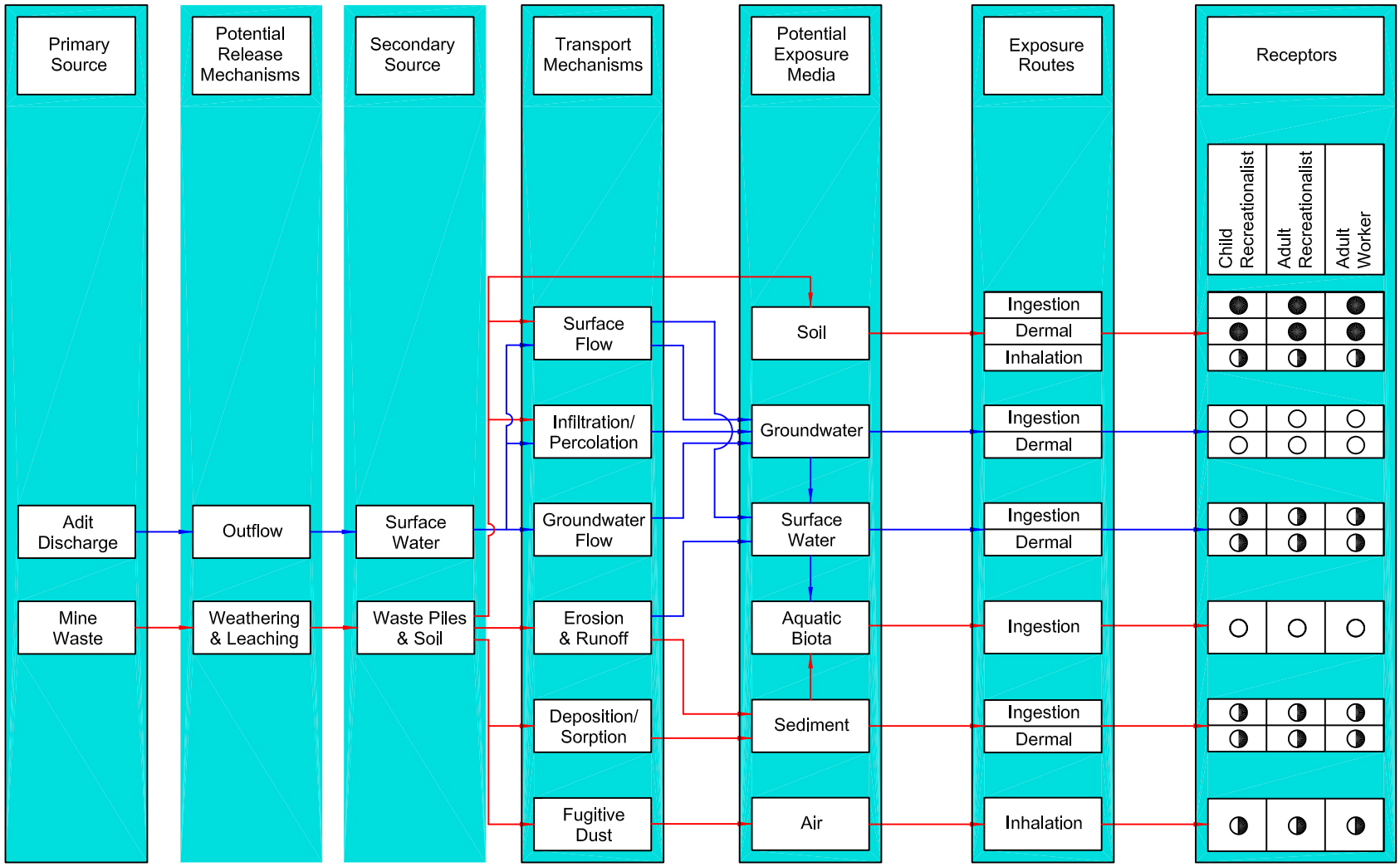
FIGURES



Legend

- ● Complete and potentially significant exposure pathway
- ◑ Potentially complete but insignificant exposure pathway
- ○ Incomplete exposure pathway

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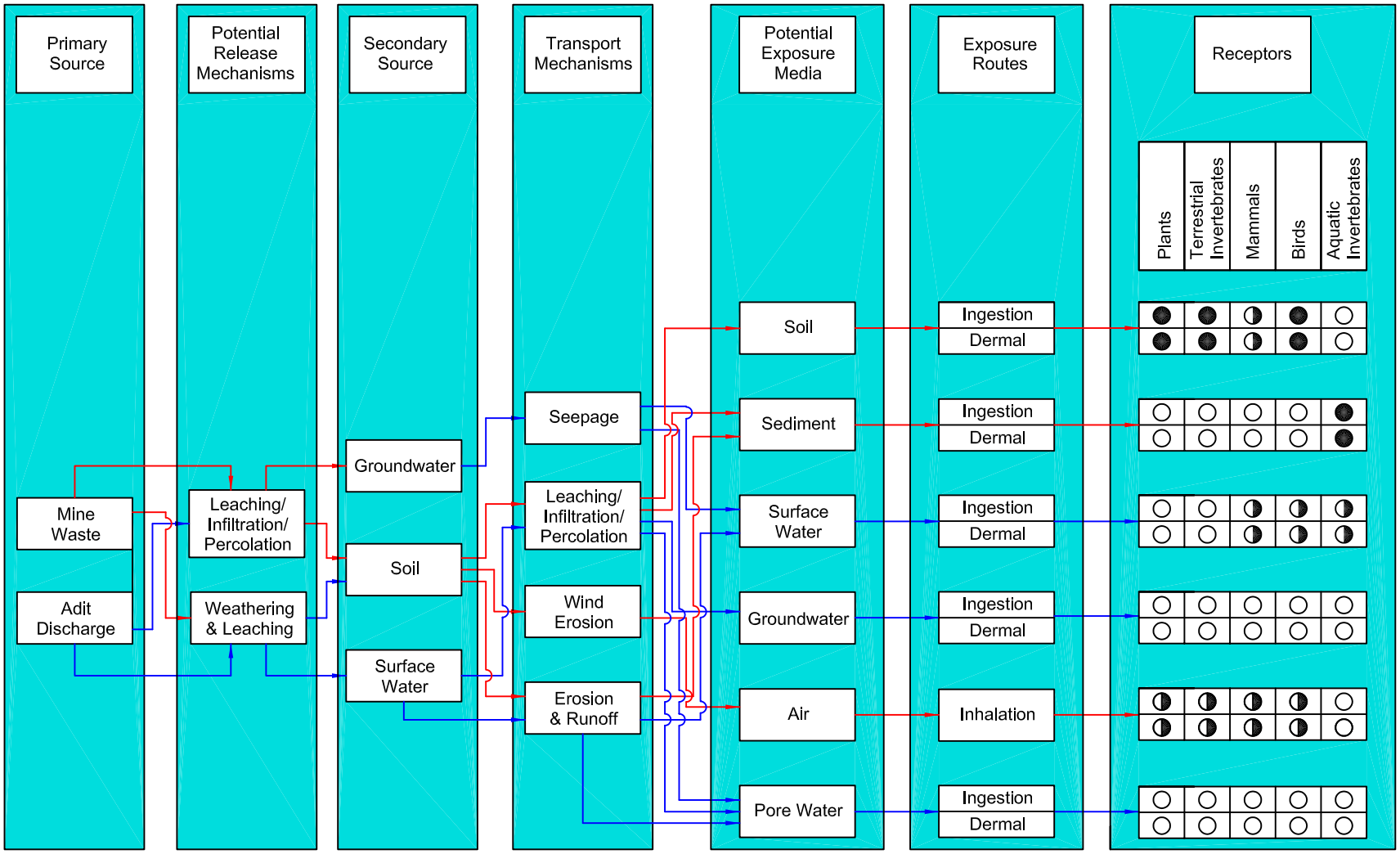
Human Health Conceptual Site Model

B2473D	9/20/08	HH CSM.dwg	FIGURE 1



Legend

- Complete and potentially significant exposure pathway
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Ecological Conceptual Site Exposure Model

B2473D	9/20/08	ERA CSM.dwg	FIGURE 2

TABLES

TABLE 1
Initial Risk Screening Using BLM Risk Management Criteria
Pyx Mine Site Inspection

Media and Receptor	Units	Contaminant of Interest									
		Sb	As	Cd	Cu	Pb	Hg	Ni	Se	Ag	Zn
HUMAN HEALTH RISK SCREENING											
Background Soil MDC	mg/kg	**1**	**7.7**	**1.51**	**15.4**	**7.65**	**0.05**	**19.3**	***2.0***	***0.25***	**82.4**
Camper RMC	mg/kg	50	20	70	5,000	1,000	40	2,700	700	700	40,000
Mine Waste MDC	mg/kg	**1.6**	**364**	**9.7**	**110**	**1,210**	**375**	**33.7**	***5.6***	**5.45**	**135**
Camper RMC	mg/kg	50	20	70	5,000	1,000	40	2,700	700	700	40,000
Sediment MDC	mg/kg	***1.0***	**7.5**	**0.1**	**34.2**	**2.91**	**0.07**	**23.1**	***2.0***	***0.25***	**33.7**
Camper RMC	mg/kg	62	46	155	5,745	1,000	46	3,094	774	774	46,455
Surface Water MDC	mg/L	***0.0015***	NA	***0.0001***	**0.0013**	***0.0015***	***0.0001***	***0.0005***	***0.0015***	***0.00006***	***0.005***
Camper RMC	mg/L	0.124	0.093	0.155	11.49	0.05	0.09	6.2	1.55	1.55	92.9
ECOLOGICAL RISK SCREENING											
Background Soil MDC	mg/kg	NC	**7.7**	**1.51**	**15.4**	**7.65**	**0.05**	NC	NC	NC	**82.4**
Deer Mouse RMC	mg/kg	NC	230	7	640	142	2	NC	NC	NC	419
Mule Deer RMC	mg/kg	NC	200	3	102	106	9	NC	NC	NC	222
Elk RMC	mg/kg	NC	328	3	131	127	11	NC	NC	NC	275
Robin RMC	mg/kg	NC	4	0.3	7	6	1	NC	NC	NC	43
Mine Waste MDC	mg/kg	NC	**364**	**9.7**	**110**	**1,210**	**375**	NC	NC	NC	**135**
Deer Mouse RMC	mg/kg	NC	230	7	640	142	2	NC	NC	NC	419
Mule Deer RMC	mg/kg	NC	200	3	102	106	9	NC	NC	NC	222
Elk RMC	mg/kg	NC	328	3	131	127	11	NC	NC	NC	275
Robin RMC	mg/kg	NC	4	0.3	7	6	1	NC	NC	NC	43

Notes:

< RMC = low risk

1 to 10X RMC = moderate risk

10 to 100X RMC = high risk

> 100X RMC = extremely high risk

BLM = U.S. Bureau of Land Management

MDC = Maximum detected concentration

NC = No RMC

RMC = Risk management criteria

mg/kg = Milligram per kilogram

mg/L = Milligram per liter

TABLE 2
Human Health Contaminant of Potential Concern Summary
Pyx Mine Site Inspection

Contaminant of Potential Concern	Media			
	Mine Waste	Surface Water	Sediment	Multimedia
Arsenic	X	X	X	X
Lead	X			X
Mercury	X			X

TABLE 3
Human Health Exposure Point Concentration Summary
Pyx Mine Site Inspection

COPC	Exposure Point Concentration					
	RME			CTE		
	Mine Waste (mg/kg)	Surface Water (mg/L)	Sediment (mg/kg)	Mine Waste (mg/kg)	Surface Water (mg/L)	Sediment (mg/kg)
Arsenic	355	0.0015	5.4	72	0.0015	5.4
Lead	1,040	0.0015	2.91	219	0.0015	2.91
Mercury	29	0.0001	0.070	29	0.0001	0.1

Notes:
COPC = Contaminant of potential concern
CTE = Central tendency exposure
RME = Reasonable maximum exposure
mg/kg = Milligram per kilogram
mg/L = Milligram per liter

TABLE 4
Human Health Exposure Factor Summary
Pyx Mine Site Inspection

Medium	Exposure Route	Parameter Code	Parameter Definition	Units	Child Recreationalist			Adult Recreationalist			Adult Worker		
					RME Value	CTE Value	Reference	RME Value	CTE Value	Reference	RME Value	CTE Value	Reference
All	All	BW	Body Weight	kg	15	15	EPA 1997a	70	70	EPA 1997a	70	70	EPA 1997a
		AT-C	Averaging Time (Cancer)	day	25,550	25,550	EPA 1997a	25,550	25,550	EPA 1997a	25,550	25,550	EPA 1997a
		AT-N	Averaging Time (Non-Cancer)	day	2,190	2,190	365 x ED	10,950	3,285	365 x ED	9,125	2,190	365 x ED
		CF1	Conversion Factor	1 kg/mg	1.E-06	1.E-06		1.E-06	1.E-06		1.E-06	1.E-06	
		CF2	Conversion Factor	L/cm^3	1.E-03	1.E-03		1.E-03	1.E-03		1.E-03	1.E-03	
Mine Waste	Ingestion	IR-S	Incidental Ingestion Rate of Soil	mg/day	400	100	EPA 1997a	100	50	EPA 1997a	480	100	EPA 1997a
		EF	Exposure Frequency	day/year	2	1	(1)	7	4	(1)	14	7	(1)
		ED	Exposure Duration	years	6	6	(1)	30	9	(1)	25	6	(1)
	Dermal	SA	Skin Surface Area Available for Contact	cm^2	2,800	2,800	EPA 2004a	5,700	5,700	EPA 2004a	3,300	3,300	EPA 2004a
		DAF	Dermal Absorption Factor	--	CS	CS	EPA 2004a	CS	CS	EPA 2004a	CS	CS	EPA 2004a
		SSAF	Soil to Skin Adherence Factor	mg/cm^2-day	1.0	0.30	EPA 2004a	0.08	0.08	EPA 2004a	1.0	0.30	ODEQ 2000a
	Inhalation	IN	Inhalation Rate	m^3/day	8	8	EPA 1997a	15	15	EPA 1997a	15	15	ODEQ 2000a
		PEF	Particulate Emission Factor	m^3/kg	1.3.E+09	1.3.E+09	EPA 2004a	1.3.E+09	1.3.E+09	EPA 2004a	1.3.E+09	1.3.E+09	EPA 2004a
Sediment	Ingestion	IR-S	Incidental Ingestion Rate of Sediment	mg/day	200	50	EPA 1997a	50	25	EPA 1997a	50	25	EPA 1997a
		EF	Exposure Frequency	day/year	2	1	(1)	7	4	(1)	14	7	(1)
		ED	Exposure Duration	years	6	6	(1)	30	9	(1)	25	6	(1)
	Dermal	SA	Skin Surface Area Available for Contact	cm^2	2,800	2,800	EPA 2004a	5,700	5,700	EPA 2004a	3,300	3,300	EPA 2004a
		DAF	Dermal Absorption Factor[a]	unitless	CS	CS	EPA 2004a	CS	CS	EPA 2004a	CS	CS	EPA 2004a
		SSAF	Soil to Skin Adherence Factor	mg/cm^2/day	1.0	0.04	EPA 2004a	0.07	0.01	EPA 2004a	1.0	0.04	EPA 2004a
Surface Water	Ingestion	IR-W	Ingestion Rate of Surface Water	L/day	0.02	0.01	EPA 1997a	0.01	0.01	EPA 1997a	0.01	0.01	EPA 1997a
		EF	Exposure Frequency	day/year	2	1	(1)	7	4	(1)	14	7	(1)
		ED	Exposure Duration	years	6	6	(1)	30	9	(1)	25	6	(1)
	Dermal	SA	Skin Surface Area Available for Contact	cm^2	2,800	2,800	EPA 2004a	5,700	5,700	EPA 2004a	3,300	3,300	EPA 2004a
		KP	Permeability Coefficient	cm/hr	CS	CS	EPA 2004a	CS	CS	EPA 2004a	CS	CS	EPA 2004a
		EVF	Event Frequency	event/day	1	1	Site specific	1	1	Site specific	1	1	Site specific
		ET	Exposure Time	hr/day	2	2	EPA 1997a	2	2	EPA 1997a	8	4	EPA 1997a

Notes:

(1) Site-specific assumed value

EPA 1997a *"Exposure Factors Handbook."* Volumes I through III. Office of Research and Development. EPA/600/P-95/002Fa, -Fb, -Fc. August.

EPA 2004a *"Risk Assessment Guidance for Superfund, Part E, Supplemental Guidance for Dermal Risk Assessment."* Volume I: Human Heath Evaluation Manual. Final. Office of Superfund Remediation and Technology Innovation. July.

ODEQ 2000a *"Guidance for Conduct of Deterministic Human Health Risk Assessments."* Final. Oregon Department of Environmental Quality (ODEQ). Updated May.

CTE = Central tendency exposure

RME = Reasonable maximum exposure

cm/hr = Centimeter per hour

cm^2 = Square centimeter

hr/day = Hour per day

kg/gm = Kilogram per milligram

L/day = Liter per day

L/cm^3 = Liter per cubic centimeter

mg/cm^2-day = Milligram per square centimeter per day

mg/day = Milligram per day

m^3/day = Cubic meter per day

m^3/kg = Cubic meter per kilogram

TABLE 5
Human Health Hazard and Cancer Risk Summary
Pyx Mine Site Inspection

Media	Exposure Pathway	CENTRAL TENDENCY EXPOSURE						REASONABLE MAXIMUM EXPOSURE					
		Child Recreationalist		Adult Recreationalist		Adult Worker		Child Recreationalist		Adult Recreationalist		Adult Worker	
		Non-carcinogenic HI	Carcinogenic ECR	Non-carcinogenic HI	Carcinogenic ECR	Non-carcinogenic HI	Carcinogenic ECR	Non-carcinogenic HI	Carcinogenic ECR	Non-carcinogenic HI	Carcinogenic ECR	Non-carcinogenic HI	Carcinogenic ECR
Mine Waste	Ingestion	0.01	2.E-07	0.003	1.E-07	0.01	3.E-07	0.2	**7.E-06**	0.05	**6.E-06**	0.4	**5.E-05**
	Dermal	0.003	1.E-07	0.001	7.E-08	0.01	2.E-07	0.1	**3.E-06**	0.01	**2.E-06**	0.2	**3.E-05**
	Inhalation	0.0000004	1.E-10	0.000001	3.E-10	0.000001	3.E-10	0.000004	1.E-09	0.00001	7.E-09	0.00001	7.E-09
	Subtotal =	0.01	3.E-07	0.004	2.E-07	0.01	4.E-07	0.3	**1.E-05**	0.06	**8.E-06**	0.6	**8.E-05**
Sediment	Ingestion	0.0002	6.E-09	0.0001	4.E-09	0.0001	5.E-09	0.001	5.E-08	0.0002	5.E-08	0.0005	8.E-08
	Dermal	0.00003	1.E-09	0.00001	7.E-10	0.00005	2.E-09	0.001	5.E-08	0.0001	3.E-08	0.002	4.E-07
	Subtotal =	0.0002	7.E-09	0.0001	5.E-09	0.0002	7.E-09	0.003	1.E-07	0.0004	8.E-08	0.003	5.E-07
Surface Water	Ingestion	0.00001	4.E-10	0.000004	2.E-10	0.00001	3.E-10	0.00003	1.E-09	0.00001	3.E-09	0.00003	4.E-09
	Dermal	0.00002	5.E-10	0.00003	1.E-09	0.0001	2.E-09	0.00003	1.E-09	0.0001	7.E-09	0.0002	3.E-08
	Subtotal =	0.00003	8.E-10	0.00003	1.E-09	0.0001	2.E-09	0.0001	2.E-09	0.0001	1.E-08	0.0003	3.E-08
TOTAL =		0.01	3.E-07	0.004	2.E-07	0.01	4.E-07	0.3	**1.E-05**	0.06	**8.E-06**	0.6	**8.E-05**

Notes:

ECR = Excess cancer risk

HI = Hazard index

Bold values exceed risk screening levels.

TABLE 6
Human Health Risk-based Hot Spot Concentrations and Cleanup Levels
Pyx Mine Site Inspection

Media	Contaminant	Risk-based Hot Spot Concentration[a] (mg/kg)	Risk-based Cleanup Level[b] (mg/kg)	Maximum Detected Concentration (mg/kg)	UCL_{90} Background Concentration (mg/kg)
Soil/Waste Rock	Arsenic	460	46	364	5.7

Notes:

[a]Based on a total cumulative excess cancer risk (ECR) of 1.E-04 for an adult worker under the reasonable maximum exposure (RME) scenario.

[b]Based on a total cumulative ECR of 1.E-05 for an adult worker under the RME scenario.

mg/kg = Milligram per kilogram

UCL_{90} = 90 percent upper confidence limit

TABLE 7
Mine Waste Contaminants of Potential Ecological Concern
Pyx Mine

Analyte	Risk from Single COI				Risk from Multiple COIs			
	Plant	Invertebrate	Bird	Mammal	Plant	Invertebrate	Bird	Mammal
Antimony	Q<5	No SLV[a]	No SLV[a]	Q<5	--	--	--	--
Arsenic III	<5%	<5%	<5%	<5%	--	--	--	--
Arsenic V	No SLV[a]	No SLV[a]	No SLV[a]	No SLV[a]	--	--	--	--
Arsenic Total	No SLV[a]	No SLV[a]	No SLV[a]	No SLV[a]	--	--	--	--
Cadmium	Q<5	Q<5	Q<5	Q<5	--	--	--	--
Chromium Total	No SLV[a]	No SLV[a]	No SLV[a]	No SLV[a]	--	--	--	--
Copper	Q<5	Q<5	Q<5	Q<5	--	--	--	--
Cyanide WAD	<5%	<5%	<5%	<5%	--	--	--	--
Cyanide Total	<5%	<5%	<5%	<5%	--	--	--	--
Iron	**X**	**X**	No SLV[a]	No SLV[a]	**X**	--	--	--
Lead	**X**	Q<5	**X**	Q<5	--	--	--	--
Mercury	**X**	**X**	**X**	Q<5	--	**X**	--	--
Nickel	Q<5	Q<5	Q<5	Q<5	--	--	--	--
Selenium	**X**	Q<5	Q<5	Q<5	--	--	--	--
Silver	Q<5	Q<5	No SLV[a]	No SLV[a]	--	--	--	--
Zinc	Q<5	Q<5	Q<5	Q<5	--	--	--	--

Notes:

[a]Retained because of the lack of an SLV; may or may not present an ecological risk.

-- Not a multiple risk CPEC.

COI = Contaminant of interest

CPEC = Contaminant of potential ecological concern

Q<5 = Screened out because risk ratio below screening level.

SLV = Screening level value

WAD = Weak acid dissociable

<5% = Screened out because not detected in more than 5% of the samples.

X = Retained as CPEC.

TABLE 8
Surface Water Contaminants of Potential Ecological Concern
Pyx Mine

Analyte	Risk from Single COI			Risk from Multiple COIs		
	Aquatic Life	Bird	Mammal	Aquatic Life	Bird	Mammal
Antimony	<5%	<5%	<5%	--	--	--
Arsenic	<5%	<5%	<5%	--	--	--
Cadmium	<5%	<5%	<5%	--	--	--
Calcium	Essential	Essential	Essential	--	--	--
Chromium	<5%	<5%	<5%	--	--	--
Copper	Q<5	Q<5	Q<5	--	--	--
Cyanide WAD	<5%	<5%	<5%	--	--	--
Cyanide Total	<5%	<5%	<5%	--	--	--
Iron	Essential	Essential	Essential	--	--	--
Lead	<5%	<5%	<5%	--	--	--
Magnesium	Essential	Essential	Essential	--	--	--
Mercury	<5%	<5%	<5%	--	--	--
Nickel	<5%	<5%	<5%	--	--	--
Selenium	<5%	<5%	<5%	--	--	--
Silver	<5%	<5%	<5%	--	--	--
Zinc	<5%	<5%	<5%	--	--	--

Notes:
[a]Retained because of the lack of an SLV; may or may not present an ecological risk.
-- Not a multiple risk CPEC.
COI = Contaminant of interest
CPEC = Contaminant of potential ecological concern
Essential = Screened out because essential nutrient.
Q<5 = Screened out because risk ratio below screening level.
SLV = Screening level value
WAD = Weak acid dissociable
<5% = Screened out because not detected in more than 5% of the samples.
X = Retained as CPEC.

TABLE 9
Sediment Contaminants of Potential Ecological Concern
Pyx Mine

Analyte	Freshwater Sediment Risk	Bioaccumulation Risk
Antimony	<5%	<5%
Arsenic III	<5%	<5%
Arsenic V	<5%	<5%
Arsenic Total	No SLV[a]	No SLV[a]
Cadmium	<5%	<5%
Chromium Total	Q<5	Q<5
Copper	Q<5	Q<5
Cyanide WAD	<5%	<5%
Cyanide Total	<5%	<5%
Iron	Essential	Essential
Lead	Q<5	Q<5
Mercury	Q<5	No SLV[a]
Nickel	Q<5	Q<5
Selenium	<5%	<5%
Silver	<5%	<5%
Zinc	Q<5	**X**

Notes:

[a]Retained because of the lack of an SLV; may or may not present an ecological risk.

Essential = Screened out because essential nutrient.

Q<5 = Screened out because risk ratio below screening level.

SLV = Screening level value

WAD = Weak acid dissociable

<5% = Screened out because not detected in more than 5% of the samples.

X = Retained as CPEC.

TABLE 10
Contaminants of Potential Ecological Concern Summary
Pyx Mine

CPEC	Media		
	Mine Waste	**Surface Water**	**Sediment**
Antimony	No SLV[a]	--	--
Arsenic V	No SLV[a]	--	--
Arsenic Total	No SLV[a]	--	No SLV[a]
Chromium Total	No SLV[a]	--	--
Iron	**P, I**	--	--
Lead	**P, B**	--	--
Mercury	**P,I,B**	--	No SLV[a]
Selenium	**P**	--	--
Silver	No SLV[a]	--	--
Zinc	--	--	**Bio**

Notes:
[a]Retained because of the lack of an SLV; may or may not present an ecological risk.
-- = Screened out
B = Bird
Bio = Bioaccumulation risk
CPEC = Contaminant of potential ecological concern
I = Invertebrate
P = Plant
SLV = Screening level value

TABLE 11
Ecological Risk Ratio Summary
Pyx Mine

	Mine Waste				Surface Water			Sediment	
CPEC	**Plant**	**Invertebrate**	**Bird**	**Mammal**	**Bird**	**Mammal**	**Aquatic Life**	**Freshwater**	**Bio-accumulation**
Antimony	<5	NS	NS	<5	--	--	--	--	--
Arsenic V	NS	NS	NS	NS	--	--	--	--	--
Arsenic Total	NS	NS	NS	NS	--	--	--	NS	NS
Chromium Total	NS	NS	NS	NS	--	--	--	<5	<5
Iron	**2,850**	**143**	NS	NS	--	--	--	--	--
Lead	**24**	<5	**65**	<5	--	--	--	<5	<5
Mercury	**1,250**	**3,750**	**100**	<5	--	--	--	<5	NS
Selenium	**6**	<5	<5	<5	--	--	--	--	--
Silver	<5	<5	NS	NS	--	--	--	--	--
Zinc	<5	<5	<5	<5	--	--	--	<5	**11**

Notes:
CPEC = Contaminant of potential ecological concern
NS = No screening level value
-- = Not calculated because not a CPEC for this media.

ATTACHMENT A

HUMAN HEALTH RISK CALCULATION TABLES

TABLE A.1
Human Health Exposure Pathways and Receptors
Pyx Mine

Scenario Timeframe	Exposure Media	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-site/ Off-site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current	Soil	Mine Waste	Recreationalist	Adult Child	Ingestion Dermal Inhalation	On-Site	Quantitative	Current (Baseline)
			Worker	Adult				
	Sediment	Adit discharge	Recreationalist	Adult Child	Ingestion Dermal	On-Site	Quantitative	Current (Baseline)
			Worker	Adult				
	Surface Water	Adit discharge	Recreationalist	Adult Child	Ingestion Dermal	On-Site	Quantitative	Current (Baseline)
			Worker	Adult				

TABLE A.2
Human Health Contaminant of Potential Concern Screening
Pyx Mine

		Mine Waste Screening											Surface Water Screening											Sediment Screening											Multimedia	
Analyte	**Essential Nutrient?**	**Detect Freq**	**Detect Freq > 5% Retain as COPC?**	**MDC (C_{ij})**	**UCL_{90} BG Conc**	**MDC>BG Retain as COPC?**	**Soil Screening Criteria[b] (PRG_{ij})**	**Units**	**R_{ij} (C_{ij}/PRG_{ij})**	**MDC>PRG Retain as COPC?**	**R_{ij}/R_j**	**Multi COI Retain as COPC?**	**Detect Freq**	**Detect Freq > 5% Retain as COPC?**	**MDC (C_{ij})**	**Avg BG Conc**	**MDC>BG Retain as COPC?**	**Surface Water Screening Criteria[c] (PRG_{ij})**	**Units**	**R_{ij} (C_{ij}/PRG_{ij})**	**MDC>PRG Retain as COPC?**	**R_{ij}/R_j**	**Multi COI Retain as COPC?**	**Detect Freq**	**Detect Freq > 5% Retain as COPC?**	**MDC (C_{ij})**	**MDC BG Conc**	**MDC>BG Retain as COPC?**	**Soil Screening Criteria[b] (PRG_{ij})**	**Units**	**R_{ij} (C_{ij}/PRG_{ij})**	**MDC>PRG Retain as COPC?**	**R_{ij}/R_j**	**Multi COI Retain as COPC?**	**Sum R_{ij}**	**Multi media Retain as COPC?**
Antimony	No	7%	**Yes**	1.6	1.0	**Yes**	410	mg/kg	3.90E-03	No	1.69E-05	No	NM	NM	*0.0015*	NM	NM	0.006	mg/L	2.68E-01	No	3.92E-04	No	NM	NM	*1.0*	NM	**Yes**	4.1E+02	mg/kg	2.44E-03	No	6.66E-04	No	2.74E-01	No
$Arsenic_{Tot}$	No	87%	**Yes**	364	5.7	**Yes**	1.6	mg/kg	2.28E+02	**Yes**	9.87E-01	**Yes**	NM	NM	*0.00150*	NM	NM	0.0000022	mg/L	6.82E+02	**Yes**	9.98E-01	**Yes**	NM	NM	5.4	NM	**Yes**	1.6E+00	mg/kg	3.38E+00	**Yes**	9.22E-01	**Yes**	9.13E+02	**Yes**
Cadmium	No	100%	**Yes**	9.65	1.24	**Yes**	450	mg/kg	2.14E-02	No	9.30E-05	No	NM	NM	*0.0001*	NM	NM	NS			No		No	NM	NM	*0.10*	NM	**Yes**	4.5E+02	mg/kg	2.22E-04	No	6.07E-05	No	2.17E-02	No
$Chromium_{tot}$	No	100%	**Yes**	25	17.3	**Yes**	450	mg/kg	5.44E-02	No	2.36E-04	No	NM	NM	*0.00125*	NM	NM	0.050	mg/L	2.50E-02	No	3.66E-05	No	NM	NM	20.4	NM	**Yes**	4.5E+02	mg/kg	4.53E-02	No	1.24E-02	No	1.25E-01	No
Copper	No	100%	**Yes**	110	14	**Yes**	41000	mg/kg	2.68E-03	No	1.16E-05	No	NM	NM	0.00125	NM	NM	1.3	mg/L	9.62E-04	No	1.41E-06	No	NM	NM	34.2	NM	**Yes**	4.1E+04	mg/kg	8.34E-04	No	2.28E-04	No	4.48E-03	No
Iron	**Yes**	100%	**Yes**	28200	12300	**Yes**	100000	mg/kg	2.82E-01	No	1.22E-03	No	NM	NM	0.074	NM	NM	0.3	mg/L	2.47E-01	No	3.61E-04	No	NM	NM	23000	NM	**Yes**	1.0E+05	mg/kg	2.30E-01	No	6.28E-02	No	7.59E-01	No
Lead	No	100%	**Yes**	1210	7.09	**Yes**	800	mg/kg	1.51E+00	**Yes**	6.56E-03	No	NM	NM	*0.0015*	NM	NM	NS			No		No	NM	NM	2.91	NM	**Yes**	8.0E+02	mg/kg	3.64E-03	No	9.94E-04	No	1.52E+00	**Yes**
Mercury	No	93%	**Yes**	375	0.05	**Yes**	310	mg/kg	1.21E+00	**Yes**	5.25E-03	No	NM	NM	*0.0001*	NM	NM	0.00014	mg/L	6.94E-01	No	1.02E-03	No	NM	NM	0.070	NM	**Yes**	3.1E+02	mg/kg	2.26E-04	No	6.17E-05	No	1.90E+00	**Yes**
Nickel	No	100%	**Yes**	33.7	16.6	**Yes**	20000	mg/kg	1.69E-03	No	7.31E-06	No	NM	NM	*0.0005*	NM	NM	0.61	mg/L	8.20E-04	No	1.20E-06	No	NM	NM	23.1	NM	**Yes**	2.0E+04	mg/kg	1.16E-03	No	3.16E-04	No	3.66E-03	No
Selenium	No	7%	**Yes**	*5.6*	*2.0*	**Yes**	5100	mg/kg	1.10E-03	No	4.76E-06	No	NM	NM	*0.0015*	NM	NM	0.17	mg/L	8.82E-03	No	1.29E-05	No	NM	NM	*2.0*	NM	**Yes**	5.1E+03	mg/kg	3.92E-04	No	1.07E-04	No	1.03E-02	No
Silver	No	53%	**Yes**	5.45	*0.25*	**Yes**	5100	mg/kg	1.07E-03	No	4.63E-06	No	NM	NM	*0.00006*	NM	NM	0.05	mg/L	1.25E-03	No	1.83E-06	No	NM	NM	*0.25*	NM	**Yes**	5.1E+03	mg/kg	4.90E-05	No	1.34E-05	No	2.37E-03	No
Zinc	No	100%	**Yes**	135	85	**Yes**	100000	mg/kg	1.35E-03	No	5.85E-06	No	NM	NM	*0.005*	NM	NM	7.4	mg/L	6.76E-04	No	9.89E-07	No	NM	NM	33.7	NM	**Yes**	1.0E+05	mg/kg	3.37E-04	No	9.21E-05	No	2.36E-03	No
Cyanide	No	0%	No	*0.25*	*0.25*	No	1200	mg/kg	2.08E-04	No	9.03E-07	No	NM	NM	*0.005*	NM	NM	0.14	mg/L	3.57E-02	No	5.23E-05	No	NM	NM	*0.25*	NM	**Yes**	1.2E+03	mg/kg	2.08E-04	No	5.69E-05	No	3.61E-02	No
		R_j = 231											**R_j =** 683											**R_j =** 4												
		N_{ij} = 13											**N_{ij} =** 11											**N_{ij} =** 13												
		$1/N_{ij}$ = 0.08											**$1/N_{ij}$ =** 0.09											**$1/N_{ij}$ =** 0.077												

Notes:
Italics - result below laboratory reporting limit (RL), value = 1/2 RL.
[a]Lower of EPA Region 9 Industrial Soil PRGs (EPA 2004b) and Oregon Industrial Maximum Allowable Soil Concentration Cleanup Levels (ODEQ 2000b).
[b]Essential nutrient
[c]Lower of EPA recommended chronic ambient water quality criteria for human consumption of water and fish (EPA 2006), and Oregon human health water quality criteria for consumption of water and fish (ODEQ 2005).
[d]Secondary contaminant that is generally limited to cosmetic or aesthetic effects, such as taste, odor, color, skin discoloration.
BG = Background
COI = Contaminant of interest
Conc = Concentration
COPC = Contaminant of potential concern
EPA = U.S. Environmental Protection Agency
MDC = Maximum detected concentration
NM = Not measured
PRG = Preliminary remediation goal
mg/kg = Milligram per kilogram
mg/L = Milligram per liter

TABLE A.3
Exposure Factors
Pyx Mine

Medium	Exposure Route	Parameter Code	Parameter Definition	Units	Child Recreationalist			Adult Recreationalist			Adult Worker		
					RME Value	CTE Value	Reference	RME Value	CTE Value	Reference	RME Value	CTE Value	Reference
All	All	BW	Body Weight	kg	15	15	EPA 1997a	70	70	EPA 1997a	70	70	EPA 1997a
		AT-C	Averaging Time (Cancer)	day	25,550	25,550	EPA 1997a	25,550	25,550	EPA 1997a	25,550	25,550	EPA 1997a
		AT-N	Averaging Time (Non-Cancer)	day	2,190	2,190	365 x ED	10,950	3,285	365 x ED	9,125	2,190	365 x ED
		CF1	Conversion Factor	1 kg/mg	1E-06	1E-06		1E-06	1E-06		1E-06	1E-06	
		CF2	Conversion Factor	L/cm^3	1E-03	1E-03		1E-03	1E-03		1E-03	1E-03	
Mine Waste	Ingestion	IR-S	Incidental Ingestion Rate of Soil	mg/day	400	100	EPA 1997a	100	50	EPA 1997a	480	100	EPA 1997a
		EF	Exposure Frequency	day/year	2	1	(1)	7	4	(1)	14	7	(1)
		ED	Exposure Duration	years	6	6	(1)	30	9	(1)	25	6	(1)
	Dermal	SA	Skin Surface Area Available for Contact	cm^2	2,800	2,800	EPA 2004a	5,700	5,700	EPA 2004a	3,300	3,300	EPA 2004a
		DAF	Dermal Absorption Factor	--	CS	CS	EPA 2004a	CS	CS	EPA 2004a	CS	CS	EPA 2004a
		SSAF	Soil to Skin Adherence Factor	mg/cm^2-day	1.0	0.3	EPA 2004a	0.08	0.08	EPA 2004a	1.0	0.3	ODEQ 2000a
	Inhalation	IN	Inhalation Rate	m^3/day	8.3	8.3	EPA 1997a	15.2	15.2	EPA 1997a	15.2	15.2	ODEQ 2000a
		PEF	Particulate Emission Factor	m^3/kg	1.31E+09	1.31E+09	EPA 2004a	1.31E+09	1.31E+09	EPA 2004a	1.31E+09	1.31E+09	EPA 2004a
Sediment	Ingestion	IR-S	Incidental Ingestion Rate of Sediment	mg/day	200	50	EPA 1997a	50	25	EPA 1997a	50	25	EPA 1997a
		EF	Exposure Frequency	day/year	2	1	(1)	7	4	(1)	14	7	(1)
		ED	Exposure Duration	years	6	6	(1)	30	9	(1)	25	6	(1)
	Dermal	SA	Skin Surface Area Available for Contact	cm^2	2,800	2,800	EPA 2004a	5,700	5,700	EPA 2004a	3,300	3,300	EPA 2004a
		DAF	Dermal Absorption Factor[a]	unitless	CS	CS	EPA 2004a	CS	CS	EPA 2004a	CS	CS	EPA 2004a
		SSAF	Soil to Skin Adherence Factor	mg/cm^2/day	1.0	0.04	EPA 2004a	0.07	0.01	EPA 2004a	1.0	0.04	EPA 2004a
Surface Water	Ingestion	IR-W	Ingestion Rate of Surface Water	L/day	0.015	0.01	EPA 1997a	0.01	0.005	EPA 1997a	0.01	0.005	EPA 1997a
		EF	Exposure Frequency	day/year	2	1	(1)	7	4	(1)	14	7	(1)
		ED	Exposure Duration	years	6	6	(1)	30	9	(1)	25	6	(1)
	Dermal	SA	Skin Surface Area Available for Contact	cm^2	2,800	2,800	EPA 2004a	5,700	5,700	EPA 2004a	3,300	3,300	EPA 2004a
		KP	Permeability Coefficient	cm/hr	CS	CS	EPA 2004a	CS	CS	EPA 2004a	CS	CS	EPA 2004a
		EVF	Event Frequency	event/day	1	1	Site specific	1	1	Site specific	1	1	Site specific
		ET	Exposure Time	hr/day	2	2	EPA 1997a	2	2	EPA 1997a	8	4	EPA 1997a

Notes:

(1) Site-specific assumed value

EPA 1997a *"Exposure Factors Handbook."* Volumes I through III. Office of Research and Development. EPA/600/P-95/002Fa, -Fb, -Fc. August.

EPA 2004a *"Risk Assessment Guidance for Superfund, Part E, Supplemental Guidance for Dermal Risk Assessment."* Volume I: Human Heath Evaluation Manual. Final. Office of Superfund Remediation and Technology Innovation. July.

ODEQ 2000a *"Guidance for Conduct of Deterministic Human Health Risk Assessments."* Final. Oregon Department of Environmental Quality (ODEQ). Updated May.

CTE = Central tendency exposure

RME = Reasonable maximum exposure

cm/hr = Centimeter per hour

cm^2 = Square centimeter

hr/day = Hour per day

kg/gm = Kilogram per milligram

L/day = Liter per day

L/cm^3 = Liter per cubic centimeter

mg/cm^2-day = Milligram per square centimeter per day

mg/day = Milligram per day

m^3/day = Cubic meter per day

m^3/kg = Cubic meter per kilogram

TABLE A.4
Exposure Point Concentrations
Pyx Mine

Contaminant of Potential Concern	Media	Arithmetic Mean	90% UCL[a]	Maximum Detected Concentration	Units	REASONABLE MAXIMUM EXPOSURE			CENTRAL TENDENCY EXPOSURE		
						Media EPC Value	Media EPC Statistic	Media EPC Rationale	Media EPC Value	Media EPC Statistic	Media EPC Rationale
Arsenic	Mine Waste	72	355	364	mg/kg	355	90% UCL	RAGS	72	Mean	RAGS
	Surface Water	NM	NM	0.00150	mg/L	0.00150	MDC	Only 1 sample	0.002	MDC	Only 1 sample
	Sediment	NM	NM	5.4	mg/kg	5.4	MDC	Only 1 sample	5.4	MDC	Only 1 sample
Lead	Mine Waste	219	1,040	1,210	mg/kg	1,040	90% UCL	RAGS	219	Mean	RAGS
	Surface Water	NM	NM	*0.0015*	mg/L	0.0015	MDC	Only 1 sample	*0.0015*	MDC	Only 1 sample
	Sediment	NM	NM	2.91	mg/kg	2.91	MDC	Only 1 sample	2.9	MDC	Only 1 sample
Mercury	Mine Waste	29	151	346	mg/kg	151	90% UCL	RAGS	29	Mean	RAGS
	Surface Water	NM	NM	*0.0001*	mg/L	0.0001	MDC	Only 1 sample	*0.0001*	MDC	Only 1 sample
	Sediment	NM	NM	0.070	mg/kg	0.07	MDC	Only 1 sample	0.1	MDC	Only 1 sample

Notes:

Italics - result below laboratory reporting limit (RL), value = 1/2 RL.

[a]UCLs not computed for sediment or surface water because fewer than 4 samples collected.

EPC = Exposure point concentration

MDC = Maximum detected concentration

NM = Not measured

RAGS = U.S. Environmental Protection Agency (EPA), 1991. *"Risk Assessment Guidance for Superfund (RAGS): Volume 1, Human Health Evaluation Manual"* (Part A), No. 9285.701A. Office of Solid Waste and Emergency Response, Washington, DC.

UCL = Upper confidence level

mg/kg = Milligram per kilogram

mg/L = Milligram per liter

TABLE A.5
Non-carcinogenic COPC Toxicity Values
Pyx Mine

Contaminant of Potential Concern	CAS Number	Chronic RfD (mg/kg-d)			Dermal Absorption Factor	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Data Source
		Oral	Dermal	Inhalation				
Arsenic	7440382	3.00E-04	1.23E-04	NA	0.03	Skin, Nervous System, Cardiovascular System	1000/1	IRIS/RAIS
Mercury	7439976	3.00E-04	2.10E-05	8.57E-05	0.001	Kidney	30/1	IRIS/RAIS

Notes:
IRIS = Integrated Risk Information System
NA = Not available
RAIS = Risk Assessment Information System
RfD = Reference dose
mg/kg-d = Milligram per kilogram per day

TABLE A.6
Carcinogenic COPC Toxicity Values
Pyx Mine

Contaminant of Potential Concern	CAS Number	Slope Factor $(mg/kg\text{-}day)^{-1}$			Type of Cancer	Weight of Evidence/Cancer Guideline Description	Data Source
		Oral	Dermal	Inhalation			
Arsenic	7440382	1.50E+00	3.66E+00	1.51E+01	Skin, lung	A	IRIS

Notes:
A = Known human carcinogen
IRIS = Integrated Risk Information System
mg/kg-day = Milligram per kilogram per day

TABLE A.7a
Non-carcinogenic Hazards - Child Recreationalist
Pyx Mine

Media	COPC	Chronic Reference Dose (mg/kg-day)			CENTRAL TENDENCY EXPOSURE SCENARIO								REASONABLE MAXIMUM EXPOSURE SCENARIO							
					CTE EPC (mg/kg); (mg/L)	Average Daily Dose (mg/kg-day)			Non-carcinogenic Hazard by Exposure Route			CTE Total Hazard	RME EPC (mg/kg); (mg/L)	Average Daily Dose (mg/kg-day)			Non-carcinogenic Hazard by Exposure Route			RME Total Hazard
		Oral	Dermal	Inhalation		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation			Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation	
Mine Waste	As	3.0E-04	1.2E-04	NA	72	1E-06	3E-07	8E-11	0.004	0.003	NA	0.01	355	5E-05	1E-05	8E-10	0.2	0.1	NA	0.3
	Hg	3.0E-04	2.1E-05	8.6E-05	29.0	5E-07	4E-09	3E-11	0.002	0.0002	0.0000004	0.002	150.7	2E-05	2E-07	3E-10	0.07	0.007	0.000004	0.08
								Mine Waste CTE Subtotal =	**0.01**	**0.003**	**0.0000004**	**0.01**				**Mine Waste RME Subtotal =**	**0.2**	**0.1**	**0.000004**	**0.3**
Sediment	As	3.0E-04	1.2E-04	NA	5.4	5E-08	3E-09	NA	0.0002	0.00003	NA	0.0002	5	4E-07	2E-07	NA	0.001	0.001	NA	0.003
	Hg	3.0E-04	2.1E-05	8.6E-05	0.070	6E-10	1E-12	NA	0.000002	0.00000007	NA	0.000002	0.1	5E-09	7E-11	NA	0.00002	0.000003	NA	0.00002
								Sediment CTE Subtotal =	**0.0002**	**0.00003**	**NA**	**0.0002**				**Sediment RME Subtotal =**	**0.001**	**0.001**	**NA**	**0.003**
Surface Water	As	3.0E-04	1.2E-04	NA	0.002	3E-09	2E-09	NA	0.00001	0.00001	NA	0.00002	0.002	8E-09	3E-09	NA	0.00003	0.00002	NA	0.0001
	Hg	3.0E-04	2.1E-05	8.6E-05	0.0001	2E-10	1E-10	NA	0.000001	0.000005	NA	0.000005	0.0001	5E-10	2E-10	NA	0.000002	0.00001	NA	0.00001
								Surface Water CTE Subtotal =	**0.00001**	**0.00002**	**NA**	**0.00003**				**Surface Water RME Subtotal =**	**0.00003**	**0.00003**	**NA**	**0.0001**
					Total CTE Non-carcinogenic Hazard =				**0.01**	**0.003**	**0.0000004**	**0.01**	**Total RME Non-carcinogenic Hazard =**				**0.2**	**0.1**	**0.000004**	**0.3**

Notes:

COPC = Contaminant of potential concern

CTE = Central tendency exposure

EPC = Exposure point concentration

NA = Not applicable

RME = Reasonable maximum exposure

mg/kg-day = Milligram per kilogram per day

mg/kg = Milligram per kilogram

mg/L = Milligram per liter

TABLE A.7b
Non-carcinogenic Hazards - Adult Recreationalist
Pyx Mine

Media	COPC	Chronic Reference Dose (mg/kg-day)			CENTRAL TENDENCY EXPOSURE SCENARIO								REASONABLE MAXIMUM EXPOSURE SCENARIO							
					CTE EPC (mg/kg); (mg/L)	Average Daily Dose (mg/kg-day)			Non-carcinogenic Hazard by Exposure Route			CTE Total Hazard	RME EPC (mg/kg); (mg/L)	Average Daily Dose (mg/kg-day)			Non-carcinogenic Hazard by Exposure Route			RME Total Hazard
		Oral	Dermal	Inhalation		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation			Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation	
Mine Waste	As	3.0E-04	1.2E-04	NA	72	6E-07	2E-07	1E-10	0.002	0.001	NA	0.003	355	1E-05	1E-06	1E-09	0.03	0.01	NA	0.04
	Hg	3.0E-04	2.1E-05	8.6E-05	29.0	2E-07	2E-09	5E-11	0.0008	0.0001	0.000001	0.001	150.7	4E-06	2E-08	5E-10	0.01	0.001	0.00001	0.01
								Mine Waste CTE Subtotal =	**0.003**	**0.001**	**0.000001**	**0.004**				**Mine Waste RME Subtotal =**	**0.05**	**0.01**	**0.00001**	**0.1**
Sediment	As	3.0E-04	1.2E-04	NA	5.4	2E-08	1E-09	NA	0.0001	0.00001	NA	0.0001	5.4	7E-08	2E-08	NA	0.0002	0.0001	NA	0.0004
	Hg	3.0E-04	2.1E-05	8.6E-05	0.070	3E-10	6E-13	NA	0.000001	0.00000003	NA	0.000001	0.07	1E-09	8E-12	NA	0.000003	0.0000004	NA	0.000004
								Sediment CTE Subtotal =	**0.0001**	**0.00001**	**NA**	**0.0001**				**Sediment RME Subtotal =**	**0.0002**	**0.0001**	**NA**	**0.0004**
Surface Water	As	3.0E-04	1.2E-04	NA	0.0015	1E-09	3E-09	NA	0.000004	0.00002	NA	0.00003	0.002	4E-09	5E-09	NA	0.00001	0.00004	NA	0.0001
	Hg	3.0E-04	2.1E-05	8.6E-05	0.0001	8E-11	2E-10	NA	0.0000003	0.00001	NA	0.00001	0.0001	3E-10	3E-10	NA	0.000001	0.00001	NA	0.00002
								Surface Water CTE Subtotal =	**0.000004**	**0.00003**	**NA**	**0.00003**				**Surface Water RME Subtotal =**	**0.00001**	**0.0001**	**NA**	**0.0001**
								Total CTE Non-carcinogenic Hazard =	**0.003**	**0.001**	**0.000001**	**0.004**				**Total RME Non-carcinogenic Hazard =**	**0.05**	**0.01**	**0.00001**	**0.1**

Notes:

COPC = Contaminant of potential concern

CTE = Central tendency exposure

EPC = Exposure point concentration

NA = Not applicable

RME = Reasonable maximum exposure

mg/kg-day = Milligram per kilogram per day

mg/kg = Milligram per kilogram

mg/L = Milligram per liter

TABLE A.7c
Non-carcinogenic Hazards - Adult Worker
Pyx Mine

					CENTRAL TENDENCY EXPOSURE SCENARIO								REASONABLE MAXIMUM EXPOSURE SCENARIO							
		Chronic Reference Dose (mg/kg-day)			CTE EPC (mg/kg); (mg/L)	Average Daily Dose (mg/kg-day)			Non-carcinogenic Hazard by Exposure Route			CTE Total Hazard	RME EPC (mg/kg); (mg/L)	Average Daily Dose (mg/kg-day)			Non-carcinogenic Hazard by Exposure Route			RME Total Hazard
Media	COPC	Oral	Dermal	Inhalation		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation			Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation	
Mine Waste	As	3.0E-04	1.2E-04	NA	72	2E-06	6E-07	1E-10	0.01	0.005	NA	0.01	355	9E-05	2E-05	1E-09	0.3	0.2	NA	0.5
	Hg	3.0E-04	2.1E-05	8.6E-05	29.0	8E-07	8E-09	5E-11	0.003	0.0004	0.000001	0.003	150.7	4E-05	3E-07	5E-10	0.1	0.01	0.00001	0.1
								Mine Waste CTE Subtotal =	**0.01**	**0.01**	**0.000001**	**0.01**				**Mine Waste RME Subtotal =**	**0.4**	**0.2**	**0.00001**	**0.6**
Sediment	As	3.0E-04	1.2E-04	NA	5.4	4E-08	6E-09	NA	0.0001	0.00005	NA	0.0002	5	1E-07	3E-07	NA	0.0005	0.002	NA	0.003
	Hg	3.0E-04	2.1E-05	8.6E-05	0.070	5E-10	3E-12	NA	0.000002	0.0000001	NA	0.000002	0.07	2E-09	1E-10	NA	0.00001	0.00001	NA	0.00001
								Sediment CTE Subtotal =	**0.0001**	**0.00005**	**NA**	**0.0002**				**Sediment RME Subtotal =**	**0.0005**	**0.002**	**NA**	**0.003**
Surface Water	As	3.0E-04	1.2E-04	NA	0.002	2E-09	5E-09	NA	0.00001	0.00004	NA	0.00005	0.002	8E-09	2E-08	NA	0.00003	0.0002	NA	0.0002
	Hg	3.0E-04	2.1E-05	8.6E-05	0.0001	1E-10	4E-10	NA	0.0000005	0.00002	NA	0.00002	0.0001	5E-10	1E-09	NA	0.000002	0.000069	NA	0.00007
								Surface Water CTE Subtotal =	**0.00001**	**0.0001**	**NA**	**0.0001**				**Surface Water RME Subtotal =**	**0.00003**	**0.0002**	**NA**	**0.0003**
					Total CTE Non-carcinogenic Hazard =				**0.01**	**0.01**	**0.000001**	**0.01**	**Total RME Non-carcinogenic Hazard =**				**0.4**	**0.2**	**0.00001**	**0.6**

Notes:

COPC = Contaminant of potential concern

CTE = Central tendency exposure

EPC = Exposure point concentration

NA = Not applicable

RME = Reasonable maximum exposure

mg/kg-day = Milligram per kilogram per day

mg/kg = Milligram per kilogram

mg/L = Milligram per liter

TABLE A.8a
Carcinogenic Risks - Child Recreationalist
Pyx Mine

					CENTRAL TENDENCY EXPOSURE SCENARIO								REASONABLE MAXIMUM EXPOSURE SCENARIO							
		Cancer Slope Factor (mg/kg-day)$^{-1}$			CTE EPC (mg/kg); (mg/L)	Average Daily Dose (mg/kg-day)			Carcinogenic Risk by Exposure Route			CTE Total Risk	RME EPC (mg/kg); (mg/L)	Average Daily Dose (mg/kg-day)			Carcinogenic Risk by Exposure Route			RME Total Risk
Media	COPC	Oral	Dermal	Inhalation		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation			Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation	
Mine Waste	As	1.5E+00	3.7E+00	1.5E+01	72	1E-07	3E-08	7E-12	2E-07	1E-07	1E-10	3E-07	355	4E-06	9E-07	7E-11	**7E-06**	**3E-06**	1E-09	**1E-05**
								Mine Waste CTE Subtotal =	**2E-07**	**1E-07**	**1E-10**	**3E-07**				**Mine Waste RME Subtotal =**	**7E-06**	**3E-06**	**1E-09**	**1E-05**
Sediment	As	1.5E+00	3.7E+00	NA	5.4	4E-09	3E-10	NA	6E-09	1E-09	NA	7E-09	5.4	3E-08	1E-08	NA	5E-08	5E-08	NA	1E-07
								Sediment CTE Subtotal =	**6E-09**	**1E-09**	**NA**	**7E-09**				**Sediment RME Subtotal =**	**5E-08**	**5E-08**	**NA**	**1E-07**
Surface Water	As	1.5E+00	3.7E+00	NA	0.002	2E-10	1E-10	NA	4E-10	5E-10	NA	8E-10	0.002	7E-10	3E-10	NA	1E-09	1E-09	NA	2E-09
								Surface Water CTE Subtotal =	**4E-10**	**5E-10**	**NA**	**8E-10**				**Surface Water RME Subtotal =**	**1E-09**	**1E-09**	**NA**	**2E-09**
								Total CTE Carcinogenic Risk =	**2E-07**	**1E-07**	**1E-10**	**3E-07**				**Total RME Carcinogenic Risk =**	**7E-06**	**3E-06**	**1E-09**	**1E-05**

Notes:

COPC = Contaminant of potential concern

CTE = Central tendency exposure

EPC = Exposure point concentration

NA = Not applicable

RME = Reasonable maximum exposure

mg/kg-day = Milligram per kilogram per day

mg/kg = Milligram per kilogram

mg/L = Milligram per liter

TABLE A.8b
Carcinogenic Risks - Adult Recreationalist
Pyx Mine

Media	COPC	Cancer Slope Factor (mg/kg-day)$^{-1}$			CENTRAL TENDENCY EXPOSURE SCENARIO								REASONABLE MAXIMUM EXPOSURE SCENARIO							
					CTE EPC (mg/kg); (mg/L)	Average Daily Dose (mg/kg-day)			Carcinogenic Risk by Exposure Route			CTE Total Risk	RME EPC (mg/kg); (mg/L)	Average Daily Dose (mg/kg-day)			Carcinogenic Risk by Exposure Route			RME Total Risk
		Oral	Dermal	Inhalation		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation			Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation	
Mine Waste	As	1.5E+00	3.7E+00	1.5E+01	72	7E-08	2E-08	2E-11	1E-07	7E-08	3E-10	2E-07	355	4E-06	6E-07	5E-10	**6E-06**	**2E-06**	7E-09	**8E-06**
								Mine Waste CTE Subtotal =	**1E-07**	**7E-08**	**3E-10**	**2E-07**				**Mine Waste RME Subtotal =**	**6E-06**	**2E-06**	**7E-09**	**8E-06**
Sediment	As	1.5E+00	3.7E+00	NA	5.4	3E-09	2E-10	NA	4E-09	7E-10	NA	5E-09	5.4	3E-08	8E-09	NA	5E-08	3E-08	NA	8E-08
								Sediment CTE Subtotal =	**4E-09**	**7E-10**	**NA**	**5E-09**				**Sediment RME Subtotal =**	**5E-08**	**3E-08**	**NA**	**8E-08**
Surface Water	As	1.5E+00	3.7E+00	NA	0.002	2E-10	3E-10	NA	2E-10	1E-09	NA	1E-09	0.002	2E-09	2E-09	NA	3E-09	7E-09	NA	1E-08
								Surface Water CTE Subtotal =	**2E-10**	**1E-09**	**NA**	**1E-09**				**Surface Water RME Subtotal =**	**3E-09**	**7E-09**	**NA**	**1E-08**
								Total CTE Carcinogenic Risk =	**1E-07**	**7E-08**	**3E-10**	**2E-07**				**Total RME Carcinogenic Risk =**	**6E-06**	**2E-06**	**7E-09**	**8E-06**

Notes:

COPC = Contaminant of potential concern

CTE = Central tendency exposure

EPC = Exposure point concentration

NA = Not applicable

RME = Reasonable maximum exposure

mg/kg-day = Milligram per kilogram per day

mg/kg = Milligram per kilogram

mg/L = Milligram per liter

TABLE A.8c
Carcinogenic Risks - Adult Worker
Pyx Mine

Media	COPC	Cancer Slope Factor (mg/kg-day)$^{-1}$			CENTRAL TENDENCY EXPOSURE SCENARIO								REASONABLE MAXIMUM EXPOSURE SCENARIO							
					CTE EPC (mg/kg); (mg/L)	Average Daily Dose (mg/kg-day)			Carcinogenic Risk by Exposure Route			CTE Total Risk	RME EPC (mg/kg); (mg/L)	Average Daily Dose (mg/kg-day)			Carcinogenic Risk by Exposure Route			RME Total Risk
		Oral	Dermal	Inhalation		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation			Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation	
Mine Waste	As	1.5E+00	3.7E+00	1.5E+01	72	2E-07	5E-08	2E-11	3E-07	2E-07	3E-10	4E-07	355	3E-05	7E-06	5E-10	**5E-05**	**3E-05**	7E-09	**8E-05**
								Mine Waste CTE Subtotal =	**3E-07**	**2E-07**	**3E-10**	**4E-07**				**Mine Waste RME Subtotal =**	**5E-05**	**3E-05**	**7E-09**	**8E-05**
Sediment	As	1.5E+00	3.7E+00	NA	5.4	3E-09	5E-10	NA	5E-09	2E-09	NA	7E-09	5.4	5E-08	1E-07	NA	8E-08	4E-07	NA	5E-07
								Sediment CTE Subtotal =	**5E-09**	**2E-09**	**NA**	**7E-09**				**Sediment RME Subtotal =**	**8E-08**	**4E-07**	**NA**	**5E-07**
Surface Water	As	1.5E+00	3.7E+00	NA	0.002	2E-10	5E-10	NA	3E-10	2E-09	NA	2E-09	0.002	3E-09	8E-09	NA	4E-09	3E-08	NA	3E-08
								Surface Water CTE Subtotal =	**3E-10**	**2E-09**	**NA**	**2E-09**				**Surface Water RME Subtotal =**	**4E-09**	**3E-08**	**NA**	**3E-08**
								Total CTE Carcinogenic Risk =	**3E-07**	**2E-07**	**3E-10**	**4E-07**				**Total RME Carcinogenic Risk =**	**5E-05**	**3E-05**	**7E-09**	**8E-05**

Notes:

COPC = Contaminant of potential concern

CTE = Central tendency exposure

EPC = Exposure point concentration

NA = Not applicable

RME = Reasonable maximum exposure

mg/kg-day = Milligram per kilogram per day

mg/kg = Milligram per kilogram

mg/L = Milligram per liter

TABLE A.9

Summary of Human Health Non-carcinogenic Hazards and Carcinogenic Risks

Pyx Mine

Media and Exposure Pathway	CENTRAL TENDENCY EXPOSURE						REASONABLE MAXIMUM EXPOSURE					
	NON-CARCINOGENIC HAZARD			CARCINOGENIC RISK			NON-CARCINOGENIC HAZARD			CARCINOGENIC RISK		
	Recreationalist Child	Recreationalist Adult	Worker Adult	Recreationalist Child	Recreationalist Adult	Worker Adult	Recreationalist Child	Recreationalist Adult	Worker Adult	Recreationalist Child	Recreationalist Adult	Worker Adult
Mine Waste:												
Ingestion	0.01	0.003	0.01	2.E-07	1.E-07	3.E-07	0.2	0.05	0.4	**7.E-06**	**6.E-06**	**5.E-05**
Dermal	0.003	0.001	0.01	1.E-07	7.E-08	2.E-07	0.1	0.01	0.2	**3.E-06**	**2.E-06**	**3.E-05**
Inhalation	0.0000004	0.000001	0.000001	1.E-10	3.E-10	3.E-10	0.000004	0.00001	0.00001	1.E-09	7.E-09	7.E-09
Subtotal =	0.01	0.004	0.01	3.E-07	2.E-07	4.E-07	0.3	0.1	0.6	**1.E-05**	**8.E-06**	**8.E-05**
Sediment:												
Ingestion	0.0002	0.0001	0.0001	6.E-09	4.E-09	5.E-09	0.001	0.0002	0.0005	5.E-08	5.E-08	8.E-08
Dermal	0.00003	0.00001	0.00005	1.E-09	7.E-10	2.E-09	0.001	0.0001	0.002	5.E-08	3.E-08	4.E-07
Subtotal =	0.0002	0.0001	0.0002	7.E-09	5.E-09	7.E-09	0.003	0.0004	0.003	1.E-07	8.E-08	5.E-07
Surface Water												
Ingestion	0.00001	0.000004	0.00001	4.E-10	2.E-10	3.E-10	0.00003	0.00001	0.00003	1.E-09	3.E-09	4.E-09
Dermal	0.00002	0.00003	0.0001	5.E-10	1.E-09	2.E-09	0.00003	0.0001	0.0002	1.E-09	7.E-09	3.E-08
Subtotal =	0.00003	0.00003	0.0001	8.E-10	1.E-09	2.E-09	0.0001	0.0001	0.0003	2.E-09	1.E-08	3.E-08
TOTAL =	0.01	0.004	0.01	3.E-07	2.E-07	4.E-07	0.3	0.1	0.6	**1.E-05**	**8.E-06**	**8.E-05**

Pathway Totals:

Ingestion	0.01	0.003	0.01	2.E-07	1.E-07	3.E-07	0.2	0.05	0.4	**7.E-06**	**6.E-06**	**5.E-05**
Dermal	0.003	0.001	0.01	1.E-07	7.E-08	2.E-07	0.1	0.01	0.2	**3.E-06**	**2.E-06**	**3.E-05**
Inhalation	0.0000004	0.000001	0.000001	1.E-10	3.E-10	3.E-10	0.000004	0.00001	0.000006	1.E-09	7.E-09	7.E-09

Notes:

Bold values exceed risk screening levels.

ATTACHMENT B

ECOLOGICAL RISK CALCULATION TABLES

TABLE B.1
Preliminary Contaminant of Potential Ecological Concern Screening - Mine Waste
Pyx Mine
(results reported in mg/kg)

Analyte	Minimum Detected Concentration	Maximum Detected Concentration	90% UCL[a]	Essential Nutrient?	Retain For Screening?	Detection Frequency	Retain for Screening?	Background 90% UCL[b]	Retain for Risk-based Screening?
Antimony	*1.0*	1.55	1.2	No	**Yes**	7%	**Yes**	*1.0*	**Yes**
Arsenic III	*7.50*	*7.50*	*7.50*	No	**Yes**	0%	No	*7.5*	No
Arsenic V	*7.70*	364	364	No	**Yes**	33%	**Yes**	*7.7*	**Yes**
Arsenic Total	*1.3*	364	355	No	**Yes**	87%	**Yes**	5.7	**Yes**
Cadmium	0.77	9.65	7.39	No	**Yes**	100%	**Yes**	1.24	**Yes**
Chromium Total	3.08	24.5	18.4	No	**Yes**	100%	**Yes**	17.3	**Yes**
Copper	26.2	110	72.2	No	**Yes**	100%	**Yes**	14.4	**Yes**
Cyanide WAD	*0.250*	*0.250*	*0.250*	No	**Yes**	0%	No	NA	No
Cyanide Total	*0.25*	*0.25*	*0.25*	No	**Yes**	0%	No	NA	No
Iron	11800	28500	22100	**Yes**	No	100%	**Yes**	12300	**Yes**[b]
Lead	3.10	1210	1040	No	**Yes**	100%	**Yes**	7.09	**Yes**
Mercury	0.0165	375	151	No	**Yes**	93%	**Yes**	0.045	**Yes**
Nickel	4.78	33.7	24.2	No	**Yes**	100%	**Yes**	16.6	**Yes**
Selenium	*2.0*	5.6	3.4	No	**Yes**	7%	**Yes**	*2.0*	**Yes**
Silver	*0.25*	5.45	4.71	No	**Yes**	53%	**Yes**	*0.25*	**Yes**
Zinc	27.8	135	72.7	No	**Yes**	100%	**Yes**	82.4	**Yes**

Notes:

[a]If the calculated 90% upper confidence limit (UCL) was greater than the maximum detected concentration (MDC), or was unable to be calculated, the MDC was used.

[b]Although an essential nutrient, retained because 90% UCL exceeds Level II SLVs from Oregon Department of Environmental Quality (ODEQ) *"Guidance for Ecological Risk Assessment"* (2001).

Italicized results indicate result below laboratory reporting limit (RL), value = 1/2 RL.

mg/kg = Milligram per kilogram

NA = Not analyzed for

SLV = Screening level value

WAD = Weak acid dissociable

TABLE B.2
Preliminary Contaminant of Potential Ecological Concern Screening - Surface Water
Pyx Mine
(results reported in mg/L)

Analyte	Minimum Detected Concentration	Maximum Detected Concentration	90% UCL[a]	Essential Nutrient?	Retain for Screening?	Detection Frequency	Retain for Risk-based Screening?
Antimony	*0.00150*	*0.00150*	*0.00150*	No	**Yes**	0%	No
Arsenic	*0.00150*	*0.00150*	*0.00150*	No	**Yes**	0%	No
Cadmium	*0.000100*	*0.000100*	*0.00010*	No	**Yes**	0%	No
Calcium	15.8	15.8	15.8	**Yes**	No	100%	No[b]
Chromium	*0.00125*	*0.00125*	*0.00125*	No	**Yes**	0%	No
Copper	0.00125	0.00125	0.00125	No	**Yes**	100%	**Yes**
Cyanide WAD	*0.0050*	*0.0050*	*0.0050*	No	**Yes**	0%	No
Cyanide Total	*0.0050*	*0.0050*	*0.0050*	No	**Yes**	0%	No
Iron	0.074	0.074	0.074	**Yes**	No	100%	No[b]
Lead	*0.00150*	*0.00150*	*0.00150*	No	**Yes**	0%	No
Magnesium	3.06	3.06	3.06	**Yes**	No	100%	No[b]
Mercury	*0.00010*	*0.00010*	*0.00010*	No	**Yes**	0%	No
Nickel	*0.00050*	*0.00050*	*0.00050*	No	**Yes**	0%	No
Selenium	*0.00150*	*0.00150*	*0.00150*	No	**Yes**	0%	No
Silver	*0.000063*	*0.000063*	*0.000063*	No	**Yes**	0%	No
Zinc	*0.0050*	*0.0050*	*0.0050*	No	**Yes**	0%	No

Notes:

[a]Only one sediment sample was collected; thus, the minimum detected concentration, the maximum detected concentration, and the 90% UCL are equal.

[b]Not retained because the analyte is an essential nutrient and either does not have a media-specific Level II SLV from ODEQ's *"Guidance for Ecological Risk Assessment"* (2001) or is below the SLV.

Italicized results indicate result below laboratory reporting limit (RL), value = 1/2 RL.

mg/L = Milligram per liter

ODEQ = Oregon Department of Environmental Quality

SLV = Screening level value

UCL = Upper confidence limit

WAD = Weak acid dissociable

TABLE B.3
Preliminary Contaminant of Potential Ecological Concern Screening - Sediment
Pyx Mine
(results reported in mg/kg)

Analyte	Minimum Detected Concentration	Maximum Detected Concentration	90% UCL[a]	Essential Nutrient?	Retain for Screening?	Detection Frequency	Retain for Risk-based Screening?
Antimony	*1.0*	*1.0*	*1.0*	No	**Yes**	0%	No
Arsenic III	*7.5*	*7.5*	*7.5*	No	**Yes**	0%	No
Arsenic V	*7.7*	*7.7*	*7.7*	No	**Yes**	0%	No
Arsenic Total	5.4	5.4	5.4	No	**Yes**	100%	**Yes**
Cadmium	*0.10*	*0.10*	*0.10*	No	**Yes**	0%	No
Chromium Total	20.4	20.4	20.4	No	**Yes**	100%	**Yes**
Copper	34.2	34.2	34.2	No	**Yes**	100%	**Yes**
Cyanide WAD	*1.25*	*1.25*	*1.25*	No	**Yes**	0%	No
Cyanide Total	*0.25*	*0.25*	*0.25*	No	**Yes**	0%	No
Iron	23000	23000	23000	**Yes**	No	100%	No[b]
Lead	2.91	2.91	2.91	No	**Yes**	100%	**Yes**
Mercury	0.070	0.070	0.070	No	**Yes**	100%	**Yes**
Nickel	23.1	23.1	23.1	No	**Yes**	100%	**Yes**
Selenium	*2.0*	*2.0*	*2.0*	No	**Yes**	0%	No
Silver	*0.25*	*0.25*	*0.25*	No	**Yes**	0%	No
Zinc	33.7	33.7	33.7	No	**Yes**	100%	**Yes**

Notes:

[a]Only one sediment sample was collected; thus, the minimum detected concentration, the maximum detected concentration, and the 90% UCL are equal.

[b]Not retained because the analyte is an essential nutrient and does not have a media-specific Level II SLV from ODEQ's *"Guidance for Ecological Risk Assessment"* (2001).

Italicized results indicate result below laboratory reporting limit (RL), value = 1/2 RL.

ODEQ = Oregon Department of Environmental Quality

SLV = Screening level value

UCL = Upper confidence limit

WAD = Weak acid dissociable

TABLE B.4
Chemistry Toxicity Screening - Mine Waste
Pyx Mine
(results reported in mg/kg)

Analyte[a]	EPC (MDC)[b]	EPC (90% UCL)[c]	SCREENING LEVEL VALUE[d]				SINGLE COI RISK RATIO (T_{ij} = EPC/SLV)				RISK TO RECEPTORS? ($T_{ij} > 5$)[f]				CPEC?	MULTIPLE COI RISK RATIO ($T_{mult} = T_{ij}/T_j$)				MULTIPLE COI RISK TO RECEPTORS? ($T_{ij}/T_i) > (5/N_{ij}$)[f]				CPEC?	Bioaccumulator CPEC?
			Plant	Invertebrate	Bird	Mammal	Plant	Invertebrate	Bird	Mammal	Plant	Invertebrate	Bird	Mammal		Plant	Invertebrate	Bird	Mammal	Plant	Invertebrate	Bird	Mammal		
Antimony	1.55	1.2	5	NS	NS	15	0.3	-	-	0.1	No	No	No	No	**Yes**[e]	0.00007	-	-	0.02830	No	No	No	No	**Yes**[e]	No
Arsenic V	364	364	NS	NS	NS	NS	-	-	-	-	No	No	No	No	**Yes**[e]	-	-	-	-	No	No	No	No	**Yes**[e]	No
Arsenic Total	364	355	NS	NS	NS	NS	-	-	-	-	No	No	No	No	**Yes**[e]	-	-	-	-	No	No	No	No	**Yes**[e]	No
Cadmium	9.65	7.39	4	20	6	125	2.4	0.5	1.2	0.06	No	No	No	No	No	0.00058	0.00012	0.00724	0.02091	No	No	No	No	No	**Yes**
Chromium Total	24.5	18.4	NS	NS	NS	NS	-	-	-	-	No	No	No	No	**Yes**[e]	-	-	-	-	No	No	No	No	**Yes**[e]	No
Copper	110	72.2	100	50	190	390	1.1	2.2	0.4	0.2	No	No	No	No	No	0.00027	0.00056	0.00223	0.06549	No	No	No	No	No	**Yes**
Iron	28500	22100	10	200	NS	NS	2850	143	-	-	**Yes**	**Yes**	No	No	**Yes**	0.68838	0.03655	-	-	**Yes**	No	No	No	**Yes**	No
Lead	1210	1040	50	500	16	4000	24	2.4	65	0.3	**Yes**	No	**Yes**	No	**Yes**	0.00585	0.00062	0.38221	0.09197	No	No	No	No	No	No
Mercury	375	151	0.3	0.1	1.5	73	1250	3750	100	2.1	**Yes**	**Yes**	**Yes**	No	**Yes**	0.30192	0.96188	0.59075	0.73024	No	**Yes**	No	Yes	**Yes**	**Yes**
Nickel	33.7	24.2	30	200	320	625	1.1	0.2	0.1	0.04	No	No	No	No	No	0.00027	0.00004	0.00044	0.01370	No	No	No	No	No	No
Selenium	5.6	3.4	1	70	2	25	5.6	0.1	1.7	0.1	**Yes**	No	No	No	**Yes**	0.00135	0.00002	0.01000	0.04811	No	No	No	No	No	**Yes**
Silver	5.45	4.71	2	50	NS	NS	2.7	0.1	-	-	No	No	No	No	**Yes**[e]	0.00066	0.00003	-	-	No	No	No	No	**Yes**[e]	**Yes**
Zinc	135	72.7	50	200	60	20000	2.7	0.7	1.2	0.004	No	No	No	No	No	0.00065	0.00017	0.00712	0.00129	No	No	No	No	No	**Yes**
						Sum of T_{ij} (T_j) =	4140	3899	170	3															
						# of COIs (N_{ij}) =	10	9	7	8															
						$1/N_{ij}$ =	0.10	0.11	0.14	0.13															
						$5/N_{ij}$ =	0.50	0.56	0.71	0.63															

Notes:
[a]Contaminants retained after preliminary screening (essential nutrient, detection frequency, and background concentration comparison).
[b]The EPC used for plant and invertebrate receptors is the maximum detected concentration.
[c]The EPC used for bird and mammal receptors is the 90% upper confidence limit (UCL).
[d]SLVs are from ODEQ's *"Guidance for Ecological Risk Assessment"* , Level II SLVs (2001).
[e]Retained because of the lack of an SLV.
[f]A screening risk ratio of 5 was used for non-protected species. No listed threatened and endangered plants, invertebrates, birds, or mammals are present at the Site.
COI = Contaminant of interest
CPEC = Contaminant of potential ecological concern
EPC = Exposure point concentration
MDC = Maximum detected concentration
NS = No SLV
ODEQ = Oregon Department of Environmental Quality
SLV = Screening level value
mg/kg = Milligram per kilogram

TABLE B.5
Chemistry Toxicity Screening - Surface Water
Pyx Mine
(results reported in mg/L)

		SCREENING LEVEL VALUE[c,d]			SINGLE COI RISK RATIO (T_{ij} = EPC/SLV)			RISK TO RECEPTORS? (T_{ij}>5)[e]			CPEC?	MULTIPLE COI RISK RATIO (T_{ij}/T_j)			MULTIPLE COI RISK TO RECEPTORS (T_{ij}/T_i) > ($1/N_{ij}$)			CPEC?
Analyte[a]	**EPC[b]**	**Aquatic Life**	**Bird**	**Mammal**	**Aquatic Life**	**Bird**	**Mammal**	**Aquatic Life**	**Bird**	**Mammal**		**Aquatic Life**	**Bird**	**Mammal**	**Aquatic Life**	**Bird**	**Mammal**	
Copper	0.00125	0.009	341	53	0.14	0.000004	0.000024	No	No	No	No	1.0000	1.0000	1.00000	No	No	No	No
				Sum of T_{ij} (T_j) =	0.14	0.000004	0.000024											
				# COIs (N_{ij}) =	1	1	1											
				$5/N_{ij}$ =	5.00	5.00	5.00											

Notes:

[a]Contaminants retained after preliminary screening (essential nutrient and detection frequency comparison).

[b]Because only one surface water sample was analyzed, the EPC is the sample concentration.

[c]SLVs corrected for hardness and dissolved fraction where applicable.

[d]SLVs are from ODEQ's *"Guidance for Ecological Risk Assessment"* , Level II SLVs (2001).

[e]A screening risk ratio of 5 was used for non-protected species. No listed threatened and endangered aquatic life, birds, or mammals are present at the Site.

COI = Contaminant of interest

CPEC = Contaminant of potential ecological concern

EPC = Exposure point concentration

mg/L = Milligram per liter

ODEQ = Oregon Department of Environmental Quality

SLV = Screening level value

TABLE B.6
Chemistry Toxicity Screening - Sediment
Pyx Mine
(results reported in mg/kg)

		SCREENING LEVEL VALUE[c]		SINGLE COI RISK RATIO (T_{ij} = EPC/SLV)		RISK TO RECEPTORS (T_{ij}>5)[d]		CPEC?
Analyte[a]	**EPC[b]**	**Freshwater Sediment**	**Bioaccumulation**	**Freshwater Sediment**	**Bioaccumulation**	**Freshwater Sediment**	**Bioaccumulation**	
Arsenic Total	5.4	NS	NS	-	-	No	No	**Yes[e]**
Chromium Total	20.4	37	4200	0.6	0.005	No	No	No
Copper	34.2	36	10	1.0	3.4	No	No	No
Lead	2.9	35	128	0.1	0.02	No	No	No
Mercury	0.1	0.2	NS	0.4	-	No	No	**Yes[e]**
Nickel	23.1	18	316	1.3	0.07	No	No	No
Zinc	33.7	123	3	0.3	11	No	**Yes**	**Yes**

Notes:

[a]Contaminants retained after preliminary screening (essential nutrient and detection frequency comparison).

[b]Because only one sediment sample was analyzed, the EPC is the sample concentration.

[c]SLVs are from ODEQ's *"Guidance for Ecological Risk Assessment"* , Level II SLVs (2001).

[d]A screening risk ratio of 5 was used for non-protected species. No listed threatened and endangered aquatic life, birds, or mammals are present at the Site.

[e]Retained because of the lack of an SLV.

CPEC = Contaminant of potential ecological concern

EPC = Exposure point concentration

MDC = Maximum detected concentration

mg/kg = Milligram per kilogram

NS = No SLV

ODEQ = Oregon Department of Environmental Quality

SLV = Screening level value

TABLE B.7
Chemistry Toxicity Screening - Multiple Media
Pyx Mine

	Single COI Risk Ratio (T_{ij})				Multiple Media Risk Ratio (T_{ij}-mine waste + T_{ij}-surface water)		Risk to Receptor ($T_{ij\text{-combined}}$>5)		CPEC?
	Mine Waste		Surface Water						
Analyte[a]	**Bird**	**Mammal**	**Bird**	**Mammal**	**Bird**	**Mammal**	**Bird**	**Mammal**	
Copper	-	-	0.000004	0.000024	0.000004	0.000024	No	No	No
Iron	-	-	-	-	-	-	No	No	No
Lead	65	0.3	-	-	65	0.3	**Yes**	No	**Yes**
Mercury	100	2.1	-	-	100	2.1	**Yes**	No	**Yes**
Nickel	1.2	0.06	-	-	1.2	0.06	No	No	No
Selenium	1.7	0.1	-	-	1.7	0.1	No	No	No
Silver	-	-	-	-	-	-	No	No	No
Zinc	1.2	0.004	-	-	1.2	0.004	No	No	No

Notes:

[a]Contaminants retained after preliminary screening (essential nutrient, detection frequency, and background concentration comparison).

COI = Contaminant of interest

CPEC = Contaminant of potential ecological concern

ATTACHMENT C

OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY ECOLOGICAL SCOPING CHECKLIST

ATTACHMENT 1
Ecological Scoping Checklist

Site Name	Pyx
Date of Site Visit	6/20/02
Site Location	Oregon
Site Visit Conducted by	T. Pamlass M. Poett D. Tibbets

Part ❶

CONTAMINANTS OF INTEREST Types, Classes, Or Specific Hazardous Substances ‡ Known Or Suspected	Onsite	Adjacent to or in locality of the facility †
Gold Mine Tailings		

‡ As defined by OAR 340-122-115(30) † As defined by OAR 340-122-115(34)

Part ❷

OBSERVED IMPACTS ASSOCIATED WITH THE SITE	Finding
Onsite vegetation (None, Limited, Extensive)	Limited
Vegetation in the locality of the site (None, Limited, Extensive)	Limited
Onsite wildlife such as macroinvertebrates, reptiles, amphibians, birds, mammals, other (None, Limited, Extensive)	None
Wildlife such as macroinvertebrates, reptiles, amphibians, birds, mammals, other in the locality of the site (None, Limited, Extensive)	None
Other readily observable impacts (None, Discuss below)	Yes
Discussion: there is a large amount of Deer tracks on the site - 6 different species of trees all seem healthy - Fauna + Flora are vigorous in the meadow and into the canopy	

ATTACHMENT 1
Ecological Scoping Checklist (cont'd)

Part ❸

SPECIFIC EVALUATION OF ECOLOGICAL RECEPTORS / HABITAT	Finding

SPECIFIC EVALUATION OF ECOLOGICAL RECEPTORS / HABITAT	Finding
Terrestrial - Wooded	
Percentage of site that is wooded	70%
Dominant vegetation type (**E**vergreen, **D**eciduous, **M**ixed)	Evergreen P *
Prominent tree size at breast height, i.e., four feet (<6", 6" to 12", >12")	6 - 12"
Evidence / observation of wildlife (**M**acroinvertebrates, **R**eptiles, **A**mphibians, **B**irds, **M**ammals, **O**ther)	Macro, Birds Mamm's
Terrestrial - Scrub/Shrub/Grasses	
Percentage of site that is scrub/shrub	20%
Dominant vegetation type (**S**crub, **S**hrub, **G**rasses, **O**ther)	Scrub P
Prominent height of vegetation (<2', 2' to 5', >5')	<2'
Density of vegetation (**D**ense, **P**atchy, **S**parse)	Sparse P
Evidence / observation of wildlife (**M**acroinvertebrates, **R**eptiles, **A**mphibians, **B**irds, **M**ammals, **O**ther)	same
Terrestrial - Ruderal	
Percentage of site that is ruderal	10%
Dominant vegetation type (**L**andscaped, **A**griculture, **B**are ground)	Landscp P
Prominent height of vegetation (0', >0' to <2', 2' to 5', >5')	Sparse
Density of vegetation (**D**ense, **P**atchy, **S**parse)	P
Evidence / observation of wildlife (**M**acroinvertebrates, **R**eptiles, **A**mphibians, **B**irds, **M**ammals, **O**ther)	Some
Aquatic - Non-flowing (lentic)	
Percentage of site that is covered by lakes or ponds	0%
Type of water bodies (**L**akes, **P**onds, **V**ernal pools, **I**mpoundments, **L**agoon, **R**eservoir, **C**anal)	
Size (acres), average depth (feet), trophic status of water bodies	
Source water (**R**iver, **S**tream, **G**roundwater, **I**ndustrial discharge, **S**urface water runoff)	
Water discharge point (**N**one, **R**iver, **S**tream, **G**roundwater, **W**etlands impoundment)	
Nature of bottom (**M**uddy, **R**ocky, **S**and, **C**oncrete, **O**ther)	P
Vegetation present (**S**ubmerged, **E**mergent, **F**loating)	P
Obvious wetlands present (**Y**es / **N**o)	
Evidence / observation of wildlife (**M**acroinvertebrates, **R**eptiles, **A**mphibians, **B**irds, **M**ammals, **O**ther)	
Aquatic - Flowing (lotic)	
Percentage of site that is covered by rivers, streams (brooks, creeks), intermittent streams, dry wash, arroyo, ditches, or channel waterway	
Type of water bodies (**R**ivers, **S**treams, **I**ntermittent Streams, **D**ry wash, **A**rroyo, **D**itches, **C**hannel waterway)	
Size (acres), average depth (feet), approximate flow rate (cfs) of water bodies	P
Bank environment (cover: **V**egetated, **B**are / slope: **S**teep, **G**radual / height (in feet))	
Source water (**R**iver, **S**tream, **G**roundwater, **I**ndustrial discharge, **S**urface water runoff)	
Tidal influence (**Y**es / **N**o)	
Water discharge point (**N**one, **R**iver, **S**tream, **G**roundwater, **W**etlands impoundment)	
Nature of bottom (**M**uddy, **R**ocky, **S**and, **C**oncrete, **O**ther)	
Vegetation present (**S**ubmerged, **E**mergent, **F**loating)	P
Obvious wetlands present (**Y**es / **N**o)	
Evidence / observation of wildlife (**M**acroinvertebrates, **R**eptiles, **A**mphibians, **B**irds,	

SPECIFIC EVALUATION OF ECOLOGICAL RECEPTORS / HABITAT	Finding
Mammals, **O**ther)	
Aquatic - Wetlands	
Obvious or designated wetlands present (**Y**es / **N**o)	Yes but seasonal
Wetlands suspected as site is/has (**A**djacent to water body, in **F**loodplain, **S**tanding water, **D**ark wet soils, **M**ud cracks, **D**ebris line, **W**ater marks)	
Vegetation present (**S**ubmerged, **E**mergent, Scrub/shrub, **W**ooded)	E/S/W **P**
Size (acres) and depth (feet) of suspected wetlands	1 acre
Source water (**R**iver, **S**tream, **G**roundwater, **I**ndustrial discharge, **Su**rface water runoff)	Surface water
Water discharge point (**N**one, **R**iver, **S**tream, **G**roundwater, **I**mpoundment)	None
Tidal influence (**Y**es / **N**o)	NO
Evidence / observation of wildlife (**M**acroinvertebrates, **R**eptiles, **A**mphibians, **B**irds, **M**ammals, **O**ther)	birds

* **P**: Photographic documentation of these features is highly recommended.

Part ❹

ECOLOGICALLY IMPORTANT SPECIES / HABITATS OBSERVED

ATTACHMENT 2
Evaluation of Receptor-Pathway Interactions

EVALUATION OF RECEPTOR-PATHWAY INTERACTIONS	Y	N	U
Are hazardous substances present or potentially present in surface waters? **AND** **Are ecologically important species or habitats present?** **AND** **Could hazardous substances reach these receptors via surface water?**			
When answering the above questions, consider the following: • Known or suspected presence of hazardous substances in surface waters. • Ability of hazardous substances to migrate to surface waters. • Terrestrial organisms may be dermally exposed to water-borne contaminants as a result of wading or swimming in contaminated waters. Aquatic receptors may be exposed through osmotic exchange, respiration or ventilation of surface waters. • Contaminants may be taken-up by terrestrial plants whose roots are in contact with surface waters. • Terrestrial receptors may ingest water-borne contaminants if contaminated surface waters are used as a drinking water source.	X	X	X
Are hazardous substances present or potentially present in groundwater? **AND** **Are ecologically important species or habitats present?** **AND** **Could hazardous substances reach these receptors via groundwater?**	X X X		
When answering the above questions, consider the following: • Known or suspected presence of hazardous substances in groundwater. • Ability of hazardous substances to migrate to groundwater. • Potential for hazardous substances to migrate via groundwater and discharge into habitats and/or surface waters. • Contaminants may be taken-up by terrestrial and rooted aquatic plants whose roots are in contact with groundwater present within the root zone (~1m depth). • Terrestrial wildlife receptors generally will not contact groundwater unless it is discharged to the surface.			

"Y" = yes; "N" = No, "U" = Unknown (counts as a "Y")

ATTACHMENT 2
Evaluation of Receptor-Pathway Interactions (cont'd)

EVALUATION OF RECEPTOR-PATHWAY INTERACTIONS	Y	N	U
Are hazardous substances present or potentially present in sediments? **AND** **Are ecologically important species or habitats present?** **AND** **Could hazardous substances reach these receptors via contact with sediments?**			
When answering the above questions, consider the following: • Known or suspected presence of hazardous substances in sediment. • Ability of hazardous substances to leach or erode from surface soils and be carried into sediment via surface runoff. • Potential for contaminated groundwater to upwell through, and deposit contaminants in, sediments. • If sediments are present in an area that is only periodically inundated with water, terrestrial species may be dermally exposed during dry periods. Aquatic receptors may be directly exposed to sediments or may be exposed through osmotic exchange, respiration or ventilation of sediment pore waters. • Terrestrial plants may be exposed to sediment in an area that is only periodically inundated with water. • If sediments are present in an area that is only periodically inundated with water, terrestrial species may have direct access to sediments for the purposes of incidental ingestion. Aquatic receptors may regularly or incidentally ingest sediment while foraging.			
Are hazardous substances present or potentially present in prey or food items of ecologically important receptors? **AND** **Are ecologically important species or habitats present?** **AND** **Could hazardous substances reach these receptors via consumption of food items?**			
When answering the above questions, consider the following: • Higher trophic level terrestrial and aquatic consumers and predators may be exposed through consumption of contaminated food sources. • In general, organic contaminants with log K_{ow} > 3.5 may accumulate in terrestrial mammals and those with a log K_{ow} > 5 may accumulate in aquatic vertebrates.			

"Y" = yes; "N" = No, "U" = Unknown (counts as a "Y")

APPENDIX C

SITE PHOTOGRAPHS

Photo 1: Partially collapsed adit (October 2007)

Photo 2: Discharge from adit (June 2008)

Photo 3: View from adit (June 2008)

Photo 4: Waste rock pile WR1 (October 2007)

Photo 5: Top of waste rock pile WR1 (June 2008)

Photo 6: Top of waste rock pile WR1 (June 2008)

Photo 7: Waste rock pile WR1 from toe (June 2008)

Photo 8: Road leading from toe of waste rock pile WR1 (June 2008)

Photo 9: View of mill frame from waste rock pile WR1 (October 2007)

Photo 10: Mill frame, concrete foundation, and debris (June 2008)

Photo 11: Debris covering mill area and potential shaft location (June 2008)

Photo 12: Conveyance channel leading to the tailings impoundment (June 2008)

Photo 13: Tailings impoundment (June 2008)

Photo 14: View of tailings impoundment from downslope of the embankment (June 2008)

Photo 15: View of tailings impoundment from upslope (June 2008)

Photo 16: Tailings impoundment and perimeter embankment (October 2007)

Photo 17: Potential repository/borrow soil source location (June 2008)

Photo 18: Collapsed structure/wood debris between mill and tailings impoundment (October 2007)